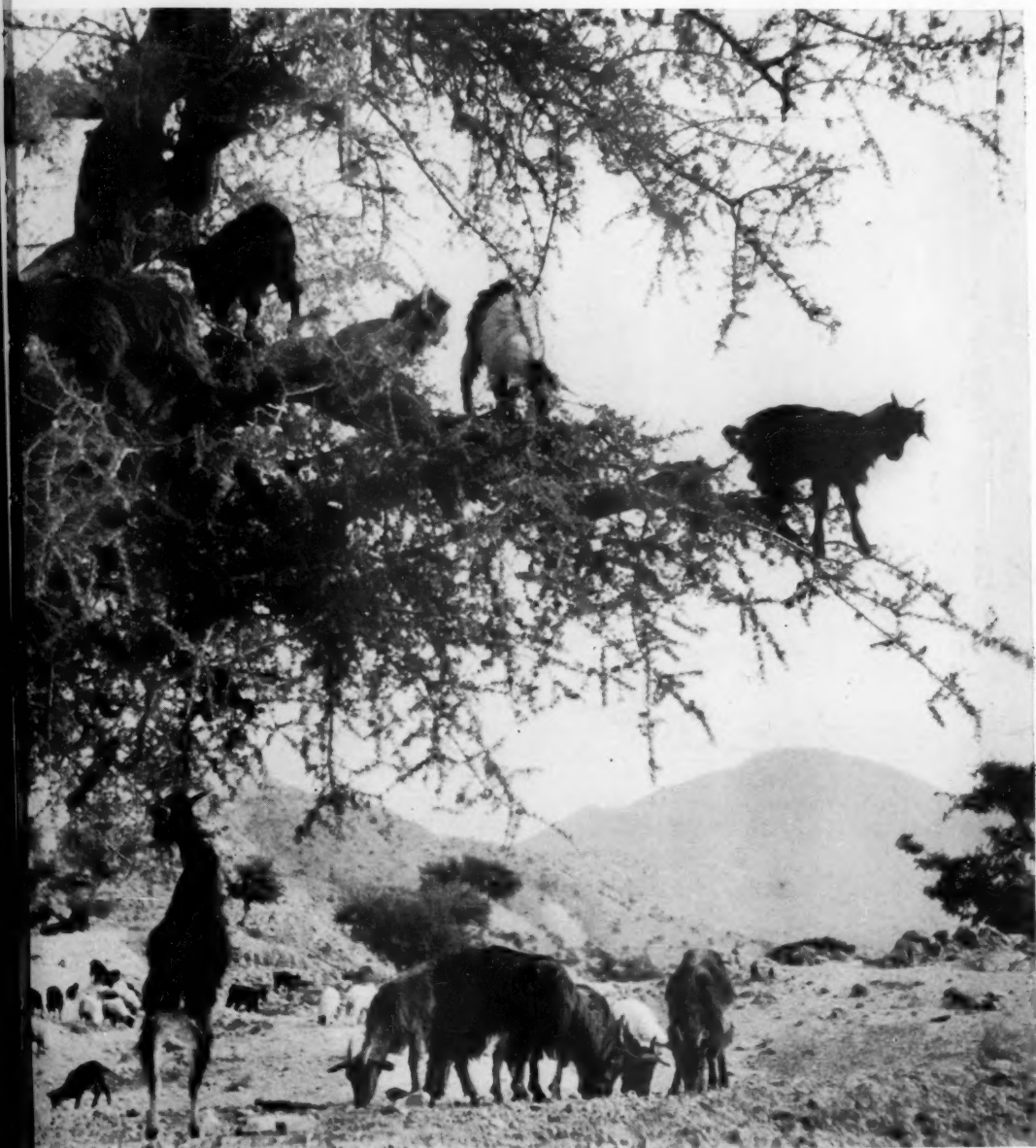


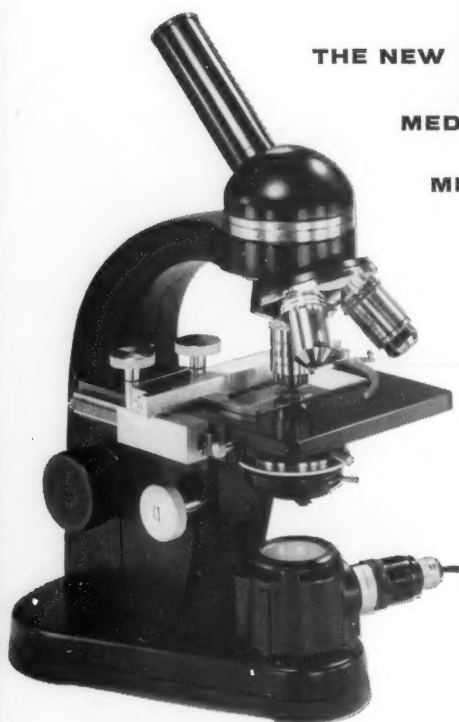
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Real Professionalism

College faculty members, like teachers in public elementary and secondary schools, should be required to hold state licenses. They should also be required to study the theory and practice of education in the course of their professional preparation. Such are two of the recommendations offered in "New Horizons," a preliminary report by the National Commission on Teacher Education and Professional Standards. The commission is a unit of the National Education Association, whose nearly three quarters of a million members are drawn principally from the ranks of school teachers and school administrators. The commission plans to publish a detailed analysis of its recommendations early next year, but in the meantime it invites discussion of its efforts to achieve what the preliminary report calls "real professionalism."

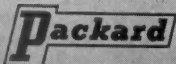
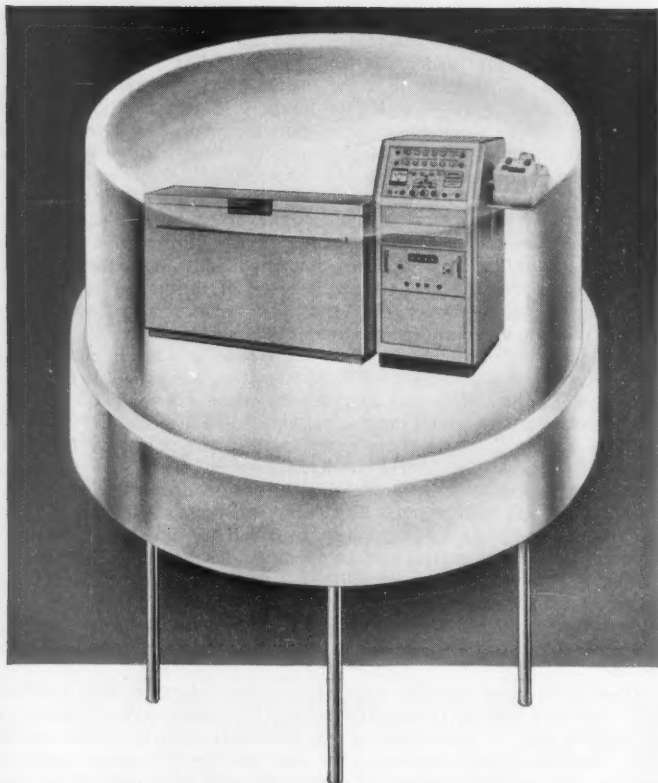
The recommendations for enlarging the licensing responsibilities of the states actually go beyond the inclusion of just college faculty members. Details are not fully spelled out, but apparently just about everyone in education but the students is to be included. At the school level, the report recommends the licensing of teachers in private and parochial schools as well as teachers in tax-supported schools. Attention is paid not only to those in front of blackboards, but also to those behind the scenes. The report recommends the licensing of all of what it calls "leadership personnel"—school principals, supervisors, and guidance officers. At the college level things get more hazy, but we may assume that in the interests of consistency, not only are all instructors in private and state institutions to be licensed, but also admissions officers, deans, and presidents. No specific mention is made of instructors at graduate faculties or professional schools, or of their leadership personnel, and perhaps the commission draws the line at this point.

The logic behind the push for equal treatment for all educational personnel is the belief that the whole of education will benefit if the parts are united. The idea of closing educational ranks is not new, and some of the present efforts in which those experienced in education at the school level are cooperating with those experienced at the university level are producing valuable results. The National Association of State Directors of Teacher Education and Certification, in conjunction with the AAAS, is conducting one such program. Its work even bears on the licensing of teachers, although instead of seeking to extend the present system, the program is seeking to correct present operating deficiencies. This cooperative effort is attempting to establish a national system of reciprocity among the states, based on national standards that include a specified minimum of subject-matter preparation, so that a teacher licensed in one state can move to another state and still be permitted to teach in public schools.

Although bringing together school and college educators may produce good results, it will not necessarily do so. The commission's interest in educational unity is commendable, but the report itself is an illustration of one kind of difficulty the search for unity presents: the groups brought together may hope for different things from such cooperation. Licenses might well change the composition of college faculties, but our guess is that the academic community as it is now composed would not regard the change as an improvement. At one point, the report offers a list of criteria in terms of which prospective teachers should be selected, and heading the list is "emotional maturity." If candidates for academic careers, not to mention present faculty members, are to face with equanimity the consequences of a closing of educational ranks as conceived in the report—assuming such circumstances ever could come to pass—then emotional maturity is something they will surely need in abundance.—J.T.



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CURRENT PROBLEMS IN RESEARCH

Deforestation in Northern Morocco

Burning, cutting, and browsing are changing a naturally wooded area into a land of scrub.

Marvin W. Mikesell

Students of the Mediterranean landscape have long been aware of the fact that scrub formations are expanding at the expense of forest, and that man and his flocks are largely responsible for this trend (1). It is no longer necessary to demonstrate that deforestation has taken place, but there is still need to assess the effects of destructive practices and determine the magnitude of change. The purpose of this article is to attempt such an assessment and determination for the Mediterranean environment of northern Morocco.

There are several reasons why it is easy to find evidence of deforestation on the African side of the Inland Sea. First and most basically, in North Africa serious erosion and a rapid increase of population necessitate constant clearing of new land. Deforestation is encouraged further by the fact that North Africans depend upon wood or charcoal for fuel. Even more important is the fact that North Africans maintain large herds of goats. Another reason why the study of deforestation is especially rewarding in North Africa is that one can find remnants of the natural plant cover preserved in cemeteries and near the shrines of holy men. Such sites often constitute islands of verdure in the midst of denuded land.

Climate and Relief

In Morocco, as in the American Southwest, relief plays an obtrusive role as a determinant of climate. The transition from Saharan to Mediterranean or Atlantic influences is abrupt where mountains form rain shadows and gradual where relief is subdued. On the Moroccan coasts, precipitation decreases toward the east and south, from 32 inches (810 millimeters) at Tangier to 16 inches (414 millimeters) at Melilla and 11 inches (287 millimeters) at Mogador (2). In highland areas exposed to Atlantic influences, annual precipitation fulfills the moisture requirements of relatively mesophytic plants. The proportion of such plants decreases on south- and east-facing slopes, and they do not occur at all in lowland areas located south of a line drawn through Rabat and Fez (Fig. 1).

Northern Morocco, the area of special interest in this article, is a land of contrasts. Moving from the Atlantic coast toward the east, the traveler is confronted with an abrupt transition from alluvial plains and terraces to a highland zone of steep slopes and narrow, knife-like ridges. Annual precipitation averages about 20 to 30 inches (500 to 800 millimeters) on the Atlantic coast, rises to 40 or 50 inches (1000 to 1500 millimeters) on exposed slopes in the highlands, and then drops to about 10 inches (250 millimeters)

in the valley of Wad Moulouya. Peaks rising above an elevation of 5000 feet (1500 meters) are snow-capped during the winter months. Generally speaking, northern Morocco can be divided into three climatic provinces: the subhumid Atlantic littoral, the humid or subhumid highlands, and the semiarid eastern plains. In each of these provinces the precipitation regime is of the Mediterranean type, with cool-season rains and summer drought.

Forest and Scrub

In northern Morocco, as elsewhere in the Mediterranean region, the prevalent vegetation can be described under the headings of "forest" and "scrub." As Fig. 2 indicates, forests now cover only a small part of the area (compare Fig. 3). The largest stands are formed of cork oak (*Quercus suber*), and the commercial importance of the bark helps to explain the preservation of the tree. The cork oak grows on consolidated dunes close to the Atlantic coast, and on sandstone outliers of the Rif chain. It is also scattered through the western half of the highlands, again largely on soils weathered from sandstone. The Moroccan fir (*Abies pinsapo*) and the Atlas cedar (*Cedrus atlantica*) are restricted to the highest peaks of the Rif chain, the former on limestone and the latter on arenaceous or schistose material. Cedar forests are also found in the High and Middle Atlas (3) (Fig. 4). The best summary that can be made of the distribution shown in Fig. 2 is that only three species form sizable forests and that most of the wooded area is in the mountains.

The more prevalent scrub formations can be subdivided into "palmetto scrub" and "thorn scrub." Palmetto scrub is so named because its most conspicuous component is the dwarf fan palm (*Chamaerops humilis*). The dominant species of thorn scrub is the jujube or "camel thorn" (*Zizyphus lotus*). For the purpose of this discussion the important facts to remember

The author is assistant professor of geography at the University of Chicago. This article is based on a paper presented 29 December 1959 at the Chicago meeting of the AAAS.

about the palmetto are that it grows rapidly, reproduces from shoots, prefers abundant light, and has roots too deep to be destroyed by the primitive Moroccan plow. Camel thorn, as the name suggests, is well adapted to survive in a land which is overrun with livestock.

In addition to the three trees mentioned above there are others that may once have formed closed stands. In the areas covered with palmetto scrub there are scattered specimens of holly oak (*Quercus ilex*), deciduous oaks (*Q. fa-*

ginea, *Q. pyrenaica*), strawberry madrone (*Arbutus unedo*), juniper (*Juniperus oxycedrus*), and the oleaster or wild olive tree (*Olea europaea* var. *oleaster*). In thorn scrub there are scattered specimens of sumac (*Rhus pentaphylla*), pistacia (*Pistacia atlantica*), and the Barbary thuya or sandarac tree (*Callitris articulata* = *Tetraclinis articulata*).

The natural ranges of most of the trees found in northern Morocco are shown in Fig. 5. Since this pattern is one of complete overlap, it is difficult

to make a case for climatically asylvatic areas. Six species—*Pistacia lentiscus*, *P. atlantica*, *Rhus pentaphylla*, *Quercus ilex*, *Pinus halepensis*, and *Callitris articulata*—grow in the driest parts of the area; and in the Atlas Mountains cedars and deciduous oaks grow on peaks higher than any in the Rif chain. Edaphic factors impose some limitations. The cork oak, for example, will not grow on calcareous soils, and most trees will not grow on poorly drained bottom land. Nevertheless, the areas that are barren of trees as a result of

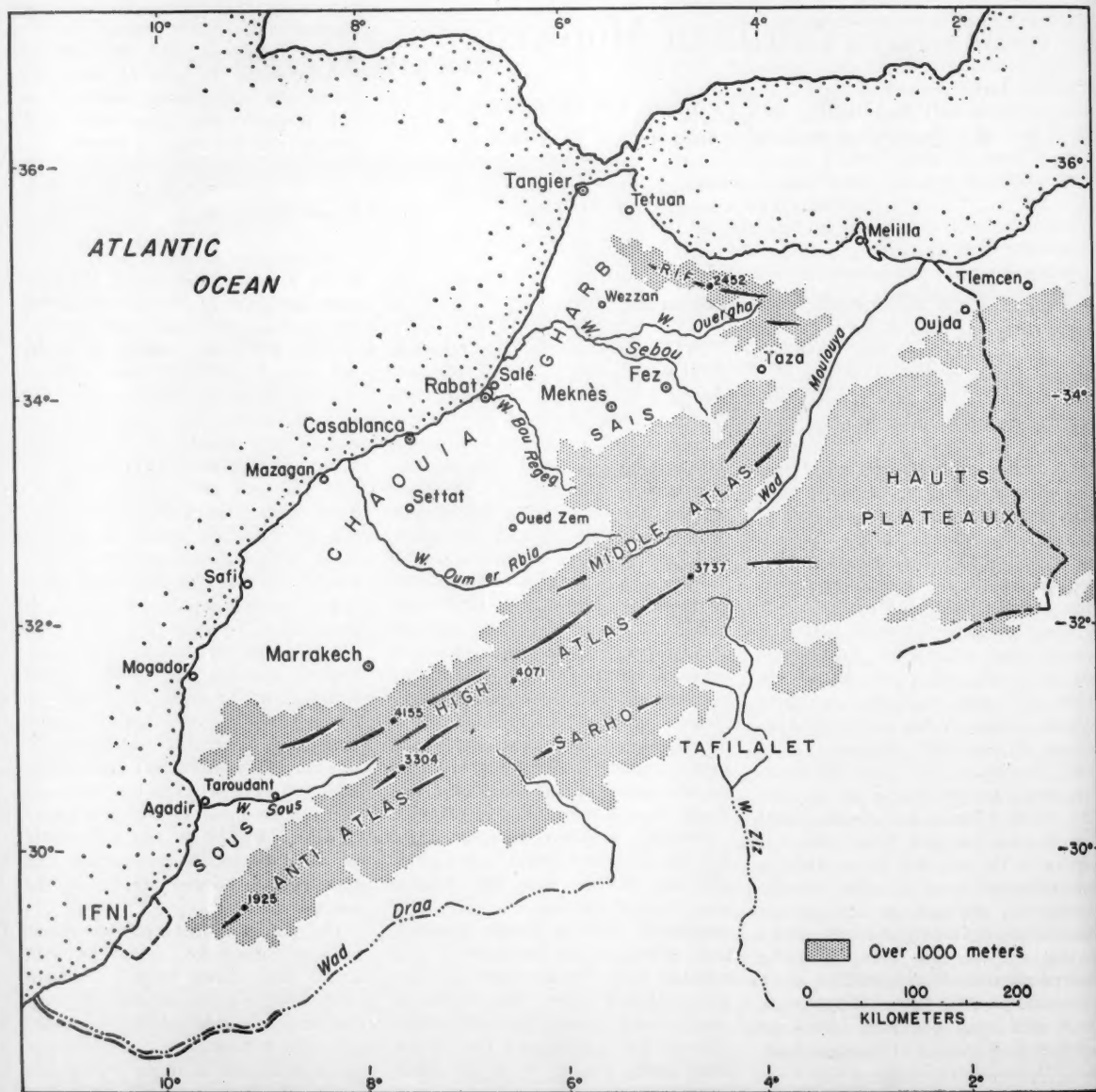
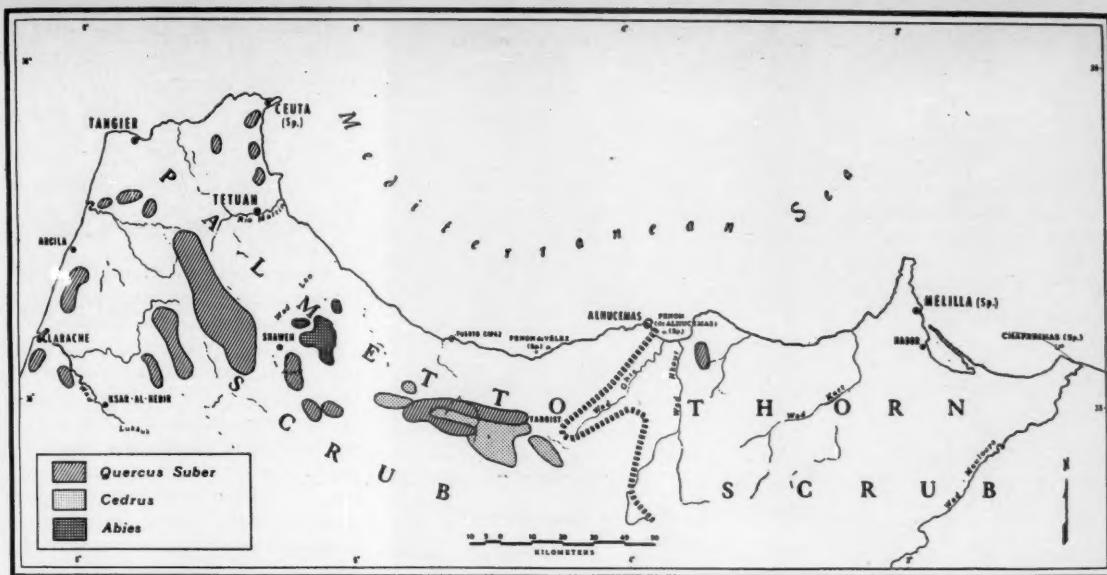


Fig. 1. Orientation map of Morocco. The area of special interest in this article is the northern or Rifian zone, which was a Spanish protectorate until April 1956.



natural causes constitute only a small part of northern Morocco.

Suggestions from History

At the beginning of the Christian era Strabo described Mount Abyla, near Ceuta, as being clothed with a mantle of great trees (4). This specific reference is interesting, for only a few

clusters of Aleppo pine appear in the area at present. It is known that Rome received wood from the North African provinces during the later period of the Empire. Beams of cedar were imported for the roofs of temples and other fine buildings, and the wood of the sandarac was imported for furniture and cabinets. The greatest of the wood-devouring industries probably was ship-building. In addition, lumber and fuel

were needed at each settlement. It would be rash to make sweeping generalizations on the basis of a few references after the lapse of centuries, yet there is reason to believe that the North African forests were depleted in Roman times (5).

The Arab conquest of North Africa in the 7th century and the great immigration of pastoral nomads from the 11th to the 14th centuries intensified

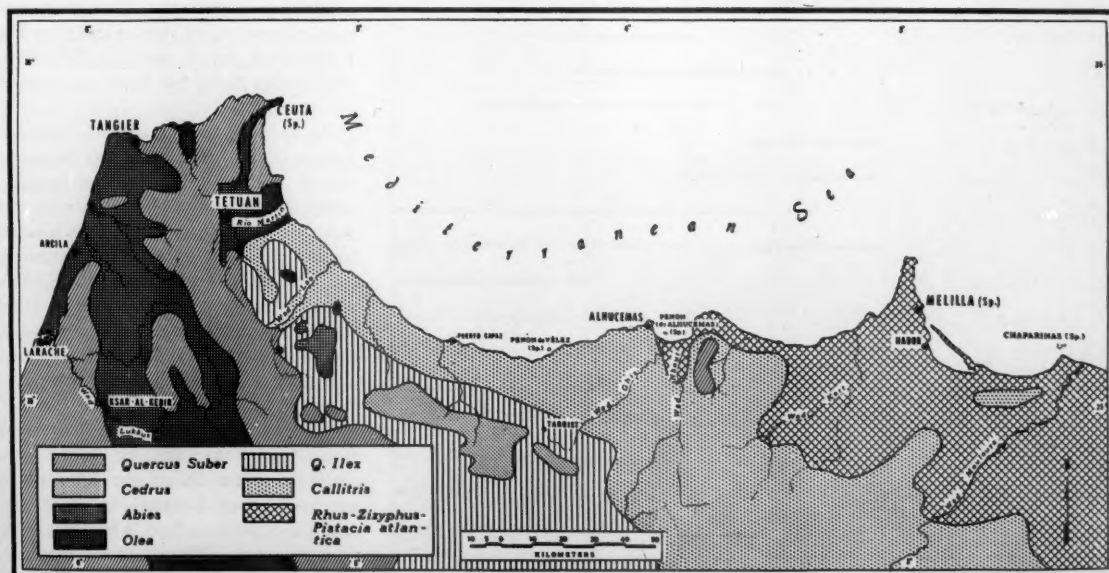


Fig. 3. Primordial or potential forests in Northern Morocco.



Fig. 4. View of the cedar forest in the Middle Atlas Mountains. The Atlas cedar (*Cedrus atlantica*) still clothes many slopes in the Moroccan mountains, but handsome specimens such as these are rare.

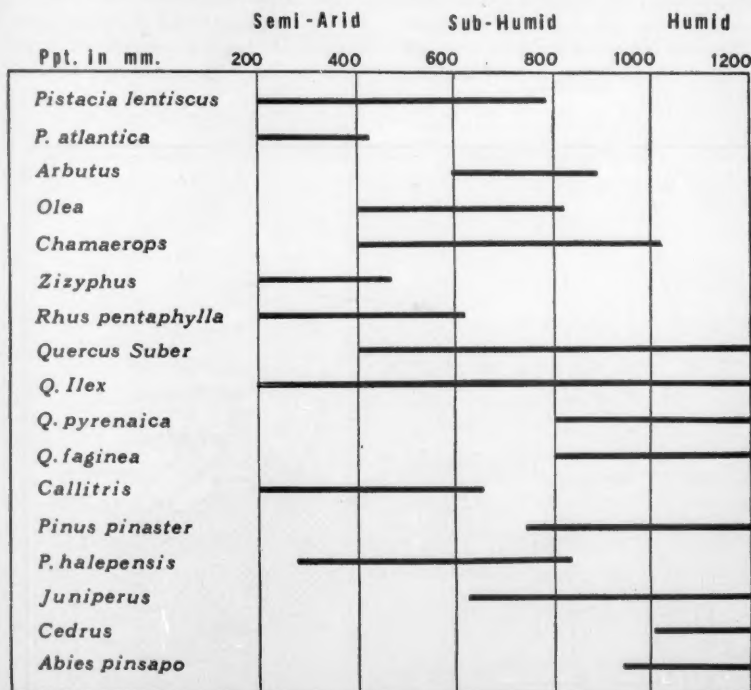


Fig. 5. Range of prominent species according to average annual precipitation (in millimeters).

destructive trends. The first Arab invaders wanted to build an urban civilization comparable to that already established in the Muslim heartland. In each new settlement wood was needed for building material, fuel, and countless domestic and industrial purposes. By the end of the 10th century the North African towns had become devourers of wood (6).

Scholars seeking a dramatic explanation of deforestation attribute most of the destruction to the nomads; one author even refers to their "hatred of trees" (7). Pastoral disturbance should be emphasized, for the havoc wrought by domestic animals lies not only in the destruction of palatable plants but also in the prevention of new growth. But it is seldom possible to distinguish one among the several causes of deforestation. It is easy to conclude that Arab nomads "destroyed" the North African forests, just as it is easy to conclude that the Mesopotamian irrigation system was "ruined" by the Mongols. In both cases, alien invasions accelerated but did not initiate the destructive trend.

During the Arab invasion of the 7th century one chronicler described North Africa as a land of "continuous shade" (8). This was probably a poetic exaggeration, for the North African highlands would appear lush and verdant even today after a trip across Egypt and Libya. Later accounts are more specific, and several of these refer to northern Morocco. Perhaps the most interesting reports are those that contain references to shipbuilding on the Rifian coast, for it would be difficult to find timber there for such an industry today.

At the end of the 15th century the forests of northern Morocco began to attract the attention of the Spanish. Moorish pirates had been raiding the Andalusian coast, and it was impossible for an unarmed vessel to pass through the Strait of Gibraltar. The distress of the Spanish resulted not only from the daring of the Moors but also from the fact that the latter had astonishingly fast and maneuverable boats. Contemporary accounts praise the "alerce" wood used in the Moorish boats and rate it higher than Spanish oak or pine. Opinions differ as to the identity of this wood, but descriptions of it suggest the sandarac. Leo Africanus (9), who visited the Rifian coast a few decades later, indicated that ships were no longer being built, and the impli-

cation of his remarks may be that shipbuilding had ceased because good specimens of "alerce" were no longer plentiful. In any case, his observations, and those of other travelers, suggest that the forests of northern Morocco had suffered substantial depletion. By the end of the 17th century most of the lowlands had been cleared.

Causes of Deforestation

The principal causes of deforestation have been and continue to be (i) domestic and industrial consumption of wood, (ii) burning to clear land for cultivation, and (iii) destruction of palatable plants by livestock. The effects of these uses and abuses are clearly evident, but it is difficult to determine their relative importance. Selective logging may regenerate a forest, but indiscriminate cutting followed by repeated burning or browsing causes deforestation. Most of the broadleaf trees reproduce from shoots, but in areas overrun by goats the shoots are browsed down and the trees that survive have a stunted and distorted form. In tangled scrub formations it is often difficult to tell whether the main agent of disturbance has been fire, teeth, or the ax.

The amount of wood consumed as charcoal must be enormous, for a brazier of some sort burns in every workshop and home. Charcoal is usually obtained from the denser hardwoods, and this preference helps to explain why most stands of the holly oak are badly degraded. Tannin is extracted from the roots and bark of many trees, and this operation causes further destruction. The cork oak is especially vulnerable, for tannin is scraped from the delicate inner bark immediately after the cork tissue has been removed. Careless stripping of the bark of the sumac, a source of red dye, also destroys many trees.

The great wooden gates that used to stand in the openings of city walls demonstrate the historic importance of the lumber trade. Only fragments of these gates still exist, but it is certain that planks of cedar were used in most towns. Logging operations were extended and intensified after the Spanish gained effective control of northern Morocco in 1928. The Spanish cut deciduous oaks for use as railroad ties and exploited cedar forests for lumber. Profiting from long experience in Algeria, the French carried on a more

constructive program in their zone. The system of management in French Morocco was based upon periodic thinnings—a procedure intended to reconcile the interests of the tribesmen with good forestry practice. If effectively enforced (but it could not be), this practice would have permitted the production of fuel before the forests had reached the normal age of exploitation, and would have improved pastoral conditions by facilitating the movement and supervision of livestock (10).

In the semiarid area east of the Rif chain the plant cover is generally too sparse to maintain fires, and on the Atlantic littoral there is little land left to clear. But in most of northern Morocco the beginning of the agricultural year, in late September, is marked by fires set to clear new fields, and the haze of smoke lingers until the arrival of the first rains. Some attempt is usually made to control the spread of fires, but conflagrations develop when tinderlike shrubs are fanned by brisk winds.

Plants that are more or less resistant to fire or are stimulated to multiply and

reproduce by fire have been called "pyrophytes" (11). There are many kinds of pyrophytes, for resistance to or stimulation from fire may be achieved in many ways. Stimulated pyrophytes are plants that grow rapidly and produce abundant seed. Among trees, the best candidate for this label is the Aleppo pine; among shrubs, the candidates are various species of the rock rose, mint, pulse, and heath families. When their aerial organs are destroyed, both the cork and holly oaks reproduce from shoots. An occasional fire may even serve to regenerate a forest, but care must be taken to prevent recurrent fires, for the secondary growth is highly inflammable. Under undisturbed conditions, forests of cedar and fir have little underbrush to serve as kindling, but the fire hazard is again increased with every proliferation of shrubs and herbs. If fires recur before seedlings reach maturity, regeneration may be impossible. The critical interval for the cedar is disadvantageously long, for the cedar does not produce abundant seed until it is 40 to 50 years old. Moreover,



Fig. 6. Effects of browsing by goats on a young cedar. Each unit of the scale is equal to 1 foot.

reproduction is difficult unless there is an opportune cycle of unusually wet years.

It would be hard to overemphasize the destruction wrought by livestock. More than a half-million sheep and a million goats are maintained in northern Morocco (12). These figures are striking in themselves, but the really impressive fact is that such a large number of animals is maintained by sedentary farmers. No tribe in northern Morocco is truly nomadic, and seasonal migration (transhumance) is practiced only by a few people in the valley of Wad Moulouya. In most of this region animals are confined within areas that they can traverse in a few hours, and there is constant consumption of palatable plants.

Most of the sheep kept in northern Morocco are in the semiarid area east of the Rif chain. Woody plants are too tough and massive to be damaged by grazing, but sheep can destroy shoots and seedlings. Where goats are numerous, deforestation is greatly accelerated,

for no hillside is too steep to daunt this prodigiously agile creature, and few plants escape its voracious appetite (Fig. 6). In Arcila, goats climb the nearly vertical Portuguese walls, and in southwestern Morocco they climb into the crowns of argan trees (*Argania spinosa*). It is not surprising that the goat should be described as an "ecologic dominant," and that many naturalists would like to see it become extinct, except in zoos (13). In this connection it may be noted that trees are sometimes protected by a cluster of relatively resistant plants. For example, in open places in cork forests young trees usually do not attain a normal form unless they are protected by a cluster of palmetto. On the semiarid plains of northeastern Morocco the pistacia rarely survives unless it is protected by a ring of camel thorn. In the Sous Valley the camel thorn plays an even more vital role as a protector of young argan trees. In the Rif mountains seedlings of cedar are sometimes protected by junipers or thorny Leguminosae.

Protected Growth on Sacred Sites

Moroccans never consciously disturb plants growing in cemeteries. Areas in the immediate vicinity of tombs or shrines of holy men are also considered sacred. To the student of plant ecology the important consequence of this attitude is that the plant cover on such sites often differs markedly from that on adjacent, profane land. This difference may be manifest in the composition and density of formations or in the height and girth of individual plants. The protected growth may be a single shrub or tree or thickets and groves. Readers of Sir James Frazer's *Golden Bough* will be aware that sacred groves and superstitions about the sanctity of trees can be found in many parts of the world. In Morocco, examples of protected vegetation are extraordinarily numerous.

In the center of sacred groves one often finds tall trees, deep shade, and little underbrush (Fig. 7). On the edge of groves, trees are replaced by shrubs and herbs that demand more light. The boundary between sacred and profane land is usually quite sharp (Fig. 8). Contrasts of this sort can be explained in two ways. In some areas the protected growth may be a remnant of the primordial cover. In other areas such growth represents regeneration encouraged by the suppression of destructive practices. Since it is seldom possible to assign specific dates to cemeteries or shrines, it is difficult to ascertain whether the vegetation on such sites indicates survival or recovery. In any case, one can speak of a contrast between *prevailing* conditions (what is) and *potential* conditions (what might be).

In the Rifian highlands the vegetation on sacred sites suggests that deforestation involves a retrogression from cedar, fir, or oak forests to formations of scrub. In the coastal lowland south of Tangier, sacred groves are usually dominated by tall oleasters (Fig. 7); in the western foothills of the Rif chain such sites are covered with cork or holly oak. Given this evidence, one can hardly avoid the inference that the natural plant cover of the subhumid area of northwestern Morocco should be a forest of oleaster or oaks, and that the present cover of palmetto scrub represents degradation. Using the same type of evidence one can recognize that the sandarac should be a tall tree and that the more prevalent dwarf forms are produced by burning or browsing. On



Fig. 7. Sacred grove of wild olive (*Olea europaea* var. Oleaster) at the shrine of a holy man. In the background the olive forest grades into a scrub formation dominated by *Pistacia lentiscus*.

the semiarid plains east of the Rif chain, sacred sites may be covered with oleaster, sandarac, sumac, or pistacia. Protected stands of one or more of these trees, and the sacred groves of Aleppo pine on the Melilla peninsula, suggest that thorn scrub is a regressive formation and not a "climax."

Magnitude of Change

The extent of deforestation is suggested by the contrasting patterns shown in Figs. 2 and 3. The details of these two maps are less important than their general outlines. One implication is clear: the present wooded area constitutes only about one-tenth of the area that would be wooded if destructive practices were suppressed. If cutting, burning, and browsing ceased, most of the area now covered with palmetto scrub would eventually be clothed with forests of oleaster (on alluvium), cork oak (on sandstone), and holly oak (on limestone). Under undisturbed conditions the provinces of the cedar and fir probably would not be greatly extended, but the existing forests would be denser and would have less underbrush. There is no reason to believe that, if disturbance were eliminated, the semiarid sector of northeastern Morocco would continue to be dominated by tussock grass, camel thorn, and other animal-resistant plants.

Conclusion

In summary, the evidence presented here supports the thesis now accepted by most students of Mediterranean vegetation, that the prevalent scrub formations are produced and maintained by man. In Morocco the principal trend has been an expansion of species that are (i) tolerant of light, (ii) resistant to drouth, (iii) relatively impalatable, and (iv) able to reproduce from shoots or to produce abundant seed. This trend is evident along the margins of many subhumid and semiarid lands. Destruction of the canopy of trees increases the amount of isolation near the ground. Hence, if deforestation takes place in subhumid or semiarid environments, mesophytic species are discouraged and colonization by more aggressive xerophytes is favored (14). In northern Morocco this process of invasion and displacement explains the prominence of plants that are more



Fig. 8. Dense cluster of Aleppo pine (*Pinus halepensis*) on the site of a cemetery. *Cistus monspeliensis* covers the slope below the lower right corner of the grove, and the gully crossing to the left contains *Nerium Oleander*. The rest of the area has been cleared.



Fig. 9. Severe gullying on a deforested slope near Melilla. This slope was probably once covered with sandarac (*Callitris articulata*) and Aleppo pine (*Pinus halepensis*).

at home in the desert or steppe. Unless the climate itself has changed, and this is not likely to have occurred within historic time (15), the proliferation of such plants should be ascribed to the disturbing influence of man.

The most unfortunate consequence of deforestation is that it increases the danger of soil erosion (Fig. 9). The steep slopes prevalent in most of northern Morocco favor rapid runoff and prevent the formation of deep residual soils. Moreover, torrential rains during the winter and spring follow vigorous mechanical weathering during the dry summer months. It would be hard to imagine an area more vulnerable to erosion, and the natural hazard is greatly increased by the destruction of protective vegetation. In northern Morocco, as elsewhere in the Mediterranean region, deforestation and erosion

are linked in a chain of causes and effects that begins with the mismanagement of land by man (16).

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Strontium-90 in Man IV

The strontium-90 concentration in human bone increased in 1958 and 1959, will probably reach a maximum in 1960.

J. Laurence Kulp, Arthur R. Schulert, Elizabeth J. Hodges

The moratorium on nuclear detonations has made it possible to define several critical factors in the distribution of fission products over the surface of the earth and their uptake in man. This article (1) gives new data on the strontium-90 content of human bone from the world-wide network of sampling stations. Earlier contributions (2-4) outlined the geographical variation, the age effect, and the mean concentration of strontium-90 in the human population. This new work permits further refinement of these parameters and indicates the situation in 1959. With the aid of important new data on the stratospheric inventory and residence times (5) and the relative im-

portance of the rate of fallout of strontium-90 as against cumulative deposition in the soil (6), it is possible to make more reliable predictions of future levels of strontium-90 in man as a result of past weapon tests. It is also possible to indicate the nature of the distribution curve for the bulk of the world population. These new data also have important implications for the situation that would exist in the event of nuclear warfare.

Since the beginning of this study, in 1953, some 9000 samples of human bone have been procured. These have included fetuses, single bone samples from individuals of all ages, and whole skeletons. The bulk of the analyses for strontium-90 have been carried out at several commercial laboratories under contract with the Atomic Energy Com-

mission (7). Most of the analyses in 1953-55 were carried out in this laboratory, and a few of the samples collected since then have been analyzed here (8).

The absolute calibration at all laboratories is based on NBS standards and is good to 2 to 3 percent. The standard deviation of the radiochemical procedures is ± 7 percent, as determined on milk samples and spiked bones with concentrations equivalent to 10 to 1000 disintegrations per minute per sample. For those human bone samples in which the level is at least 5 disintegrations per minute, the over-all reproducibility among the various laboratories is about ± 10 percent. This category includes virtually all children's bones, all whole-skeleton ash samples from individuals who died from 1957 to 1960, and large samples consisting of many bones from adults who died in 1958, 1959, and 1960, from the latitude band 30° to 70° N. The other samples, of lower strontium-90 activity, carry larger errors. Laboratory contamination was monitored with analytical reagent grade $\text{Ca}_3(\text{PO}_4)_2$ and human bone from individuals who died before 1945. Samples of adult bone containing less than 2.0 grams of calcium and children's bones containing less than 0.5 gram of calcium have not been included in this summary because of the larger inherent errors resulting from the low total activity. From 1958 on, most adult bones were composited, equal weights

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Table 1. Average strontium-90 concentrations (in micromicrocuries per gram of calcium) in the skeletons of adults of various age groups. Number of samples in parentheses.

Population	Age group (yr)					
	20-29	30-39	40-49	50-59	60-69	70 and over
New York whole skeletons (normalized to 1957)	0.071 \pm 0.008 (4)	0.098 \pm 0.015 (9)	0.080 \pm 0.009 (17)	0.092 \pm 0.006 (67)	0.097 \pm 0.005 (94)	0.094 \pm 0.004 (125)
Western culture area (single bones, 1957)	0.14 \pm 0.03 (26)	0.18 \pm 0.03 (29)	0.14 \pm 0.02 (40)	0.12 \pm 0.02 (46)	0.13 \pm 0.02 (52)	0.10 \pm 0.02 (48)

of bone from each autopsy being used, since the major effort was directed toward establishment of the best mean for a given station. As will be seen below, the data were adequate for analytical examination of population variations.

In the earlier years (1954-56) the specific activity of strontium-90 in single adult bones was so low that in some of the samples none was detectable. These samples were generally reported as having a specific activity of less than twice the standard-deviation counting error in micromicrocuries of strontium-90 per gram of calcium. In all the averages reported below, this was taken as the maximum value for the concentration of strontium-90 for these samples. The average is not appreciably affected if such samples are assumed to have zero concentration of strontium-90.

In an earlier article (3) it was shown that the strontium-90 concentration in adults is essentially independent of age. Therefore, in the discussion and tables these were treated as a homogeneous class regardless of the age at death. Further information is now available in support of this assumption. Table 1 gives comparisons for various groups of adults. The analytical error is considerably smaller in the case of the large, whole-skeleton samples. It may be seen that there is no significant trend with age. The uncertainty indicated for each group in Table 1 is the standard error of the mean.

Since it has not been possible to obtain large numbers of whole skeletons except in New York City, most individuals are represented by single bones. It is essential, therefore, to know the relation of the specific activity of the analyzed piece of bone to the whole skeleton. Earlier work by Schulert *et al.* (9) showed that in skeletons of children (ten fetuses, nine young children, and one teen-ager) the specific activity was essentially uniform, whereas in adults the activity in the vertebrae was higher, and that in the long-bone shaft lower, than the body average as a result of

the differing exchange rates in the different bones.

Table 2 gives the average ratios for vertebrae, rib, skull, and long-bone shaft to whole skeleton for 19 fetuses. They show uniform strontium-90 distribution within the limits of experimental error—a finding which is not unexpected since the deposition of new bone is the dominant process during this part of the life span.

The accuracy of the earlier determinations in adults was not as high as in 1957-1959, due to the very low concentrations of strontium-90 in the bones. The measurements were, therefore, repeated with individuals who died in 1958 and 1959. Because of the higher activity in the whole skeletons collected in New York City in 1958 and 1959, a more accurate estimate of the distribution of strontium-90 in the human skeleton could be made. Four composite samples of the most important bones were assembled. Each composite contained an equal weight of ash of a given bone type from five individuals. The results are given in Table 3. By weighting the specific activity in accordance with the quantity of a given bone type in the skeleton, the skeletal average is obtained. The ratios of levels in the key bones to levels in the whole skeleton are given in Table 4. These average values were used to compute the skeletal levels of strontium-90 from the individual adult bone samples. The earlier values are given for comparison. Values for all samples have now been corrected in accordance with these new, and more accurate, ratios. The standard deviation of about 10 percent largely

reflects analytical error. These data do not provide an estimate of the variation of these ratios among individuals. They do suggest that the standard deviation in these ratios among individuals does not exceed 10 percent.

Strontium-90 Concentration and Age

Since strontium-90 has been present in the diet of human beings for a relatively short time and the rate of turnover of existing bone is slow, the average strontium-90 concentration in the adult skeleton is much lower than that in newly depositing bone. In children the value is strongly dependent on the age of the individual. The average skeletal level for any age at any time can be calculated if the following factors are known: (i) the discrimination factor between strontium and calcium in passing from diet to bone; (ii) the average weight of calcium added to the skeleton at each age; (iii) the average concentration of strontium-90 in the diet of the individual since birth; (iv) the average rate of turnover of mature bone; and (v) the discrimination factor between strontium and calcium from mother's diet to fetus.

The discrimination factor between strontium and calcium from diet to bone is now clearly established for the average Western diet as 4 against strontium (10-12). The average weight of calcium deposited each year in the skeletons of children in the United States was derived from the data of Mitchell *et al.* (13) and Watson and Lowrey (14). The strontium-90 concentration in the average Western diet has been computed from available data (15-18). The primary basis is the yearly average from the various milk-distribution networks. Kulp and Slakter (16), Bryant *et al.* (11), and Bird and Mar (18) have shown that for Western culture areas, the average ratio of strontium-90 to calcium in the total diet is about 1.2 times the ratio for milk alone. The following average diet levels,

Table 2. Comparison of strontium-90 concentrations in various bones of 19 fetuses.

	Vertebrae/ skel.	Rib/ skel.	Skull/ skel.	Long-bone shaft/ skel.
Average	1.0	1.0	1.0	1.0
S.D.*	0.3	0.3	0.1	0.3
S.E.†	0.1	0.1	0.02	0.1

* Standard deviation.

† Standard error.

Table 3. Distribution of strontium-90 in composite bone samples (in micromicrocuries per gram of calcium).

Bone	Composite sample No.			
	A	B	C	D
Vertebrae	0.209 \pm 0.007	0.268 \pm 0.007	0.424 \pm 0.009	0.371 \pm 0.009
Rib	0.192 \pm 0.008	0.149 \pm 0.009	0.254 \pm 0.008	0.226 \pm 0.008
Tibia	0.049 \pm 0.005	0.054 \pm 0.007	0.079 \pm 0.006	0.078 \pm 0.006
Femur	0.061 \pm 0.005	0.054 \pm 0.007	0.069 \pm 0.007	0.097 \pm 0.006
Tibia joint	0.121 \pm 0.007	0.081 \pm 0.008	0.190 \pm 0.010	0.168 \pm 0.008
Femur joint	0.100 \pm 0.007	0.071 \pm 0.007	0.240 \pm 0.008	
Calculated body av.	0.121	0.109	0.189	0.198

in micromicrocuries of strontium-90 per gram of calcium, for Western culture areas were chosen on the basis of these data: 1954, 2; 1955, 4; 1956, 6; 1957, 8; 1958, 11; and 1959, 15.

When the average strontium-90 concentration in adult bone samples for 1957, 1958, and 1959, the dietary level for 1953-59, and the discrimination factor are known, it is possible to calculate the empirical average rate of exchange (19) in whole adult skeletons from this dietary history. The empirical value determined in this way, with fall-out strontium-90 as a tracer, is 3.3 percent per year. This value is empirical for the interval in question and reflects the rapid rate of turnover for the most active centers. The long-term average rate is lower because the rate of exchange is lower in the rest of the skeleton (4). The long-term exchange rate

could be ascertained by this method if the concentration of strontium-90 in the diet remained constant over long periods.

The placental discrimination between the mother's blood and the offspring's bone has been determined experimentally, by Comar *et al.* (20), for cows and rats to be about 2 against strontium. This might suggest a discrimination factor of 8 against strontium from the mother's diet to the fetus. Actually, the observed concentration of strontium-90 in fetal skeletons in 1957, 1958, and 1959 averages one-twelfth that in the mother's diet. The explanation for this may be the addition of calcium of very low strontium-90 concentration from the mother's skeleton, plus the prescription of extra mineral calcium for pregnant women. For the purpose of determining

the theoretical curve for the strontium-90 concentrations versus age in children, the observed average strontium-90 concentration in fetuses has been used.

Theoretical curves were calculated for 1957, 1958, and 1959 (Fig. 1), based on the assumptions given above. The average obtained from analysis of the bones of individuals who died in 1958 in each age group, with standard error, is also given in this figure. It may be seen that the fit of the data to the theoretical curve is quite good, except that the data do not follow the peak in the 10 to 14 age interval. The maximum occurs at about 1 year of age and is about 10 times the adult level. In 1958 the world average for adults must have been about 0.2 micromicrocurie of strontium-90 per gram of calcium, unless the value for the adult population of China (for which data were not available) greatly exceeds the mean for the rest of the world. This world average increased by about 40 percent in 1959.

Time Effect

If large numbers of samples or restricted types are compared, it is possible to see the regular increase in the specific activity of the human skeleton since the start of the testing of large

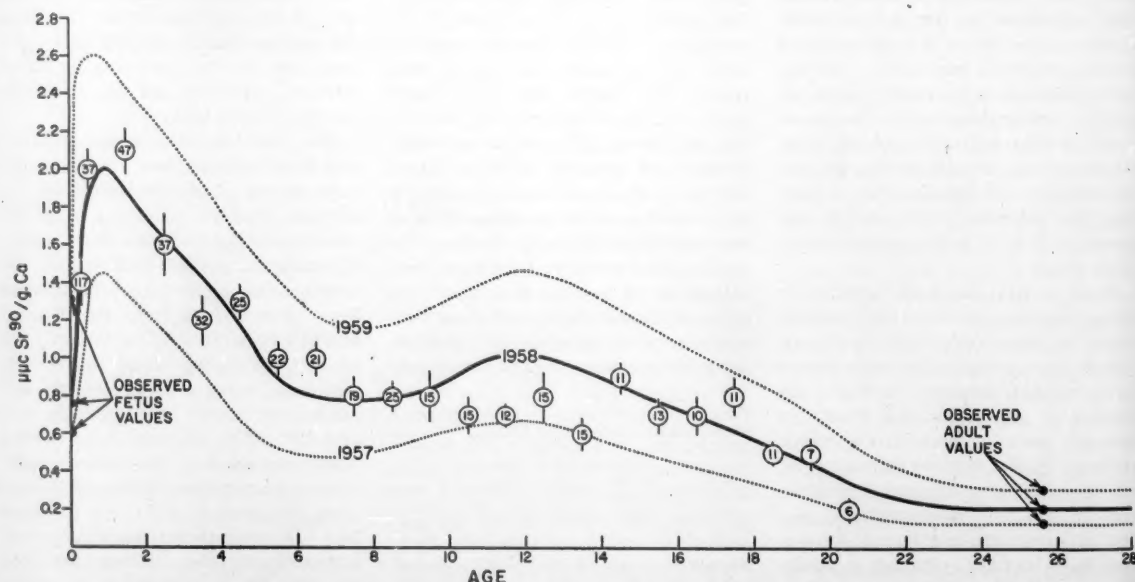


Fig. 1. Calculated curves showing expected strontium-90 concentration in the bones of children and young people in Western culture areas for 1957, 1958, and 1959; the experimental data include the number of samples in each age group for 1958.

Table 4. Ratio of strontium-90 and strontium-85 concentrations in individual bones to concentration in the whole skeleton.

Composite sample No.	Vertebra/skel.	Rib/skel.	Long-bone shaft/skel.
<i>This study (Sr⁹⁰ in 1958-59 N.Y. cadavers)</i>			
A	1.7	1.6	0.45
B	2.4	1.4	0.50
C	2.2	1.3	0.40
D	1.9	1.1	0.47
Average	2.1	1.4	0.45
S.E.*	0.1	0.1	0.02
<i>Sr⁸⁵, single dose (earlier study) (10)</i>			
	4.8	2.1	0.6
<i>Sr⁹⁰ in 1956 N.Y. cadavers (2)</i>			
	3.4 ± 0.8	1.5 ± 0.4	0.8 ± 0.2
<i>Sr⁹⁰ in 1957 N.Y. cadavers (9)</i>			
	1.8 ± 0.2	1.1 ± 0.2	0.5 ± 0.1

* Standard error.

nuclear weapons. Table 5 shows the data for the whole-skeleton samples from New York City, plus data from whole fetuses and single bones from adults and young children in Western culture areas, in the latitude band 30°-70°N. For the latter compilation the measurements by Bryant *et al.* (21) on children's bones from the United Kingdom and those on Chicago fetuses by Libby in 1954 (22) are included.

The percentage standard deviation for the New York cadavers shows a consistent decrease from 1954 to 1958, due to the rising level of activity in the samples. The standard error of the mean is small compared with the yearly increment in specific activity. For 1959 the largest percentage increase in activity is seen in the fetus population, a consequence of the fact that fetuses are in equilibrium with the dietary level of the year in which they are born. It was not possible to report standard errors on the adult-bone groups for 1958 and 1959, since most of these samples were composites, but the standard errors would probably have been quite similar to those given for 1957 had the samples been analyzed individually.

The average values for each station for sample categories 0 to 4 years, 5 to 19 years, and adult, for 1958 and 1959, are listed in Table 6. Included in the averages are the data of Bryant (21) covering the United Kingdom and Australia and a few measurements by the AEC's Health and Safety Laboratory (15). As may be seen from data in Table 5, the standard deviation for large sets of single adult bones from an area in which diet is reasonably uniform is about 80 percent. Thus,

since the annual increase in concentration in the diet has been only approximately 50 percent, useful comparisons can be made only between stations with fairly large numbers of samples. If, for example, 70 samples are analyzed, the standard error of the mean should not exceed 10 percent, a value which is similar to the analytical error.

From 1957 through 1959, the strontium-90 level in the milk supply of St. Louis, Missouri, was higher than the average for the United States by a factor of about 2, according to the samples obtained by the U.S. Public Health Service. Therefore, even in the area of Western culture, large populations may have dietary levels that differ by a factor of 2. The standard deviation of the annual average strontium-90 level in milk from stations in the United States does not exceed 45 percent of the mean. Thus, the difference in levels between Houston, Texas, and Bonn, Germany, may merely reflect the different levels in milk from the two milksheds during 1959.

Although Puerto Rico lies at latitude 18°N and receives less fallout per inch of rainfall than the average for Western culture areas in latitude band 30° to 70°N, the difference is compensated for by the higher ratio of nonmilk sources to milk sources in the diet. The same principle probably holds for the Recife, Brazil, station. The fact that the average for adults in Thailand is 50 percent higher than that for Western culture areas between latitudes 30° and 70°N although the fallout in Thailand is lower by a factor of 2 to 4 is also probably related to the difference in the diet.

Distribution Curve

The average value for strontium-90 concentration in adult bone at a given station for a given year may be determined with an accuracy of 5 to 10 percent if at least 100 samples are involved (see Table 5). Since this is comparable to the analytical error, analysis of more than 100 samples for a given station would not appear to be warranted. The average for fetuses at a given station may likewise be determined with an accuracy equivalent to the analytical error if 50 to 100 samples are obtained.

The average for individuals between birth and 20 years can best be determined for any given year from the calculated curves in Fig. 1, after making the empirical correction for the 10-14 age span. The ends of these curves have been anchored to experimental averages for adults and fetuses.

The distribution about the mean for any age in any year and at any station is best determined from large samples in which the analytical error is relatively small, such as the whole-skeleton samples from New York City. All of these samples have been normalized to 1957, and the results are plotted in Fig. 2B. A comparable histogram for all 1958 fetuses from Chicago, New York, and England (areas which had similar diets) is given in Fig. 2A and shows essentially the same distribution and standard deviation. The high values of about 1.4 micromicrocurie of strontium-90 per gram of calcium for one group of fetus samples may result from special diets associated with pregnancy. This distribution curve (Fig. 2, A and B) is probably representative of the pop-

Table 5. Strontium-90 concentration (in micromicrocuries per gram of calcium) in human bone from 1953 through 1959. Number of samples in parentheses. S.D., standard deviation; S.E., standard error.

Sample group	Year					
	1953	1954	1955	1957	1958	1959
<i>New York</i>						
Whole skeleton:						
Average	<0.005 (2)	0.007 (26)	0.027 (58)	0.051 (131)	0.097 (73)	0.134 (28)
S.D.		0.009	0.020	0.036	0.045	0.044
S.E.		0.002	0.003	0.003	0.005	0.008
<i>Western culture area</i>						
Whole fetuses:						
Average		0.12 (185)		0.59 (54)	0.67 (269)	1.21 (76)
S.D.				0.25	0.27	0.39
S.E.				0.03	0.02	0.06
Single adult bones:						
Average		0.07 (36)	0.11 (184)	0.10 (139)	0.13 (317)	0.21 (184)
S.D.		0.08	0.09	0.07	0.10	0.31 (101)
S.E.		0.01	0.01	0.01	0.01	
0-4 yr.:						
Average			0.5 (39)	0.7 (53)	1.2 (70)	1.7 (58)
						2.3 (59)

ulation of any age group at any station in Western culture areas (standard deviation, approximately 40 percent). The distribution curve for single adult bones from all stations in Western culture areas is considerably wider (Fig. 2C) (standard deviation, approximately 80 percent). This was to have been expected, since (i) the analytical error in individual samples of this type is 20 to 30 percent instead of 10 percent, as in the case of fetuses or whole skeletons; (ii) there is at least an additional 10-percent uncertainty introduced in the estimation of the whole-skeleton value from the single-bone analysis; and (iii) the average strontium-90 concentration in the diet varies from one station to the next. For example, the

average adult in New York in 1957 and 1958 carried half the concentration of strontium-90 carried by the average adult in Bonn, Germany. Thus, the distribution curve for all single-bone samples, even for single-bone samples from Western culture areas only, may be biased by the relative contribution from the various stations. For the reasons given above, this distribution is probably broader than the actual distribution in adults in Western culture areas. It may be seen from this curve that at least 90 percent of this population will lie within 2 times the mean and that 97 percent will lie within 3 times the mean. All samples lie within 10 times the mean. The distribution for any specified metropolitan area is

given much more accurately by Fig. 2B.

There are not enough samples available from any single station in the rice-diet area to define closely the distribution curve. However, the standard deviation for 33 single-adult-bone samples from Thailand in 1957 was 75 percent of the mean, and for 39 samples from Japan, 55 percent of the mean; these findings suggest that there is no large difference in the character of the distribution curve for these areas as compared to Western localities.

It is possible to estimate the distribution for the adult population of the United States in 1958 from the milk data. This is done by calculating the yearly average for as many stations as possible, grouping these findings into ten large areas by similarity of activity, and weighting for the population of the areas. The data are then plotted, on the assumption that the shape of the curve for whole-skeleton samples from New York City is valid for any single-milkshed area. The curve in Fig. 2D represents a summation of the individual curves calculated in this way. The spread is greater than that for a single area (for example, New York City) and less than the result obtained for single-bone analyses throughout Western culture areas, for reasons discussed above.

Future Levels

Various predictions have been made concerning the probable future levels of strontium-90 in bone as a result of nuclear detonations set off before and during 1958 (2-4, 23, 27). It now appears that all of these estimates were too high and that the peaks for diet, and hence for children's bones, were set too far in the future. These calculations were based on the then available estimates of the size of the stratospheric reservoir (2 to 5 megacuries) and of the half-residence time (5 to 10 years) (24) and on the assumption that all of the strontium-90 in the diet passed through the soil. H. Feely, of Isotopes, Incorporated (5), has shown from high-altitude air-sampling studies conducted in cooperation with the Department of Defense that the quantity of strontium-90 in the stratosphere is much less than had been previously estimated (0.6 megacurie in the fall of 1959) and that from nuclear events such as those produced by the U.S.S.R. in October 1958, half of the debris had already been deposited in 6 months.

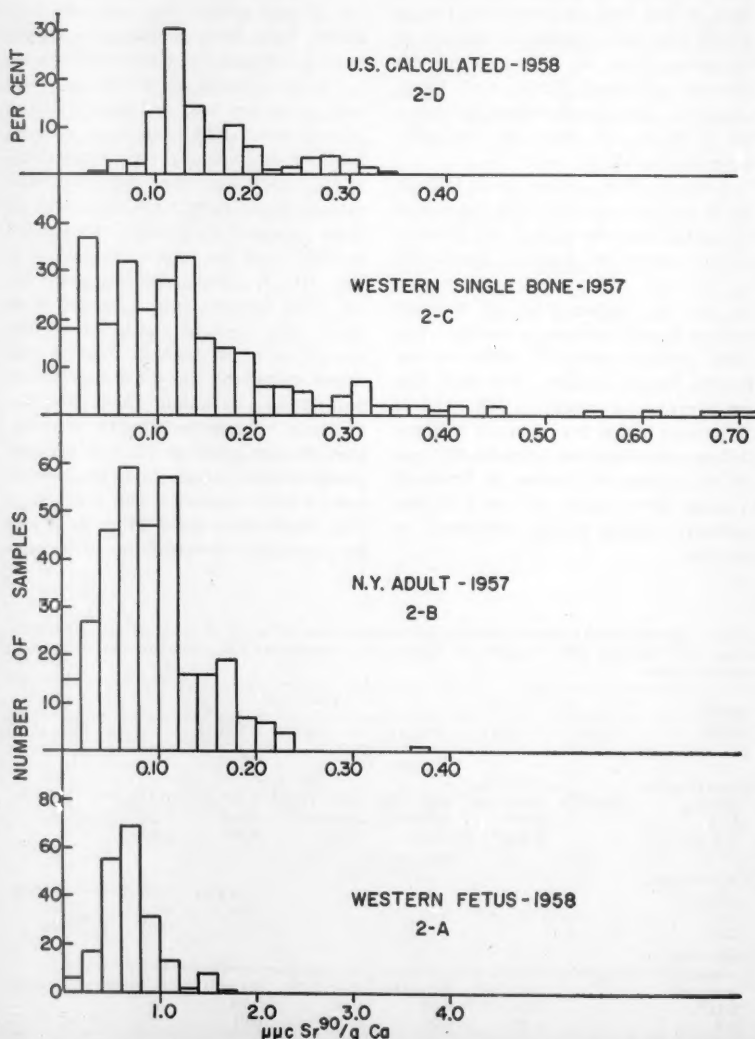


Fig. 2. Distribution curves for strontium-90 concentrations in various population groups.

From clouds introduced near the equator, of the sort produced by Operation Hardtack, half of the debris is on the ground in less than 1 year. Walton (25) has shown that probably the most accurate estimate of the quantity of strontium-90 on the ground at the end of 1959 was 4.5 megacuries, so it is clear that (i) the strontium-90 yet to be deposited is a small fraction of that already down, and (ii) the total surface deposit will reach a maximum in 1961.

Evidence has been accumulating to show that direct uptake of strontium-90 from rain by plants is the dominant mechanism by which strontium-90 enters the diet of human beings. The most definitive experiment was done by R. S. Russell's group at the Agricultural Research Council Radiobiological Laboratory in the United Kingdom (6). In this it was shown, from activity in milk produced in England and Wales in 1958, that no more than 20 percent of the strontium-90 in the 1958 diet could be accounted for by uptake by grass through the soil, and thus that 80 percent must have been taken into the grass directly from rain. Thus, the rate of fallout under weather conditions of 1954 through 1959 was much more important than the cumulative deposit in determining the dietary level. Since the rate of fallout has already dropped below the 1958 level, it appears that the peak of strontium-90 concentration in the world diet has already occurred, in 1959, and the peak in newly depositing bone will occur this year.

From the inventory values and the

Table 6. Average concentrations of strontium-90 (in micromicrocuries per gram of calcium) in human bone in 1958 and 1959. Number of samples in parentheses.

Station	1958			1959		
	0-4 yr	5-19 yr	Adult	0-4 yr	5-19 yr	Adult
<i>30°-70°N, Western culture area</i>						
New York	2.1 (16)	0.9 (2)	0.13 (28)	2.8 (5)	1.1 (4)	
Boston	1.5 (3)	0.9 (12)				
Houston	1.6 (8)	1.6 (2)	0.17 (67)			0.23 (46)
Bismarck, N.D.			0.40 (3)			
Vancouver	1.9 (4)	0.8 (21)		2.0 (1)	1.1 (5)	
England	1.4 (50)	0.8 (19)	0.17 (15)	2.7 (27)	1.0 (19)	0.25 (4)
Germany (Bonn)	1.7 (18)	0.6 (11)	0.34 (61)	2.0 (23)	0.8 (7)	0.38 (55)
Israel	0.2 (6)	0.2 (2)	0.16 (27)	1.6 (3)	0.7 (1)	
<i>30°-70°N, Orient</i>						
Japan (Tokyo)		0.7 (2)	0.17 (30)		0.6 (1)	
<i>10°N to 20°S</i>						
Puerto Rico	0.64 (20)	0.65 (10)	0.21 (137)		0.89 (19)	0.28 (51)
Guatemala	0.1 (1)	0.3 (5)	0.08 (28)			
Taiwan		0.8 (4)	0.20 (11)		1.1 (1)	
Thailand (Bangkok)		0.39 (1)	0.30 (10)			
<i>10°N to 20°S</i>						
Brazil (Recife)	0.72 (3)	0.49 (10)	0.16 (25)	1.96 (8)	0.32 (6)	0.15 (70)
Belgian Congo						
Leopoldville	1.5 (1)	0.27 (1)	0.07 (4)	1.0 (1)		
Colombia (Barranquilla)		0.2 (2)	0.03 (2)			0.06 (5)
<i>20°S</i>						
South Africa						
Durban-Capetown		0.95 (22)	0.22 (2)		0.92 (17)	
Australia	0.60 (52)	0.33 (25)	0.12 (65)		0.46 (2)	0.23 (22)
Chile (Santiago)		0.46 (8)		0.39 (17)	0.27 (16)	

residence times indicated above, and the value of 20 percent for the contribution of the cumulative deposit to the level of strontium-90 in the diet, it is possible to calculate the change in the average concentration of strontium-90 in the skeletons of people of any age as a result of nuclear tests to date. Figure 3 shows the probable curve (solid line) for the distribution of strontium-90 in Western man in 1959. It also shows projected curves to 1970 for the skeletal burden in individuals who,

in 1959, were 1, 15, and 26 years old, respectively. It may be seen that concentrations in adults will increase slightly and then level off toward the equilibrium level for new bone determined by the diet. Levels in one-year-olds will rise slightly but then will drop sharply toward the equilibrium level. Fifteen-year-olds have much more total strontium-90 (and calcium) built in, and hence their skeletal levels will fall more slowly than those of the one-year-olds, but all will approach the equilibrium level in their lifetimes.

Russell's estimate of the soil uptake is a maximum; thus, the equilibrium level may be lower than that shown here. The actual ratio of direct uptake to soil uptake for the entire North American continent will be much clearer from the milk-network measurements by the end of 1960, since the rate of fallout will be down by at least a factor of 4 over the 1959 rate and the cumulative deposit will be essentially unchanged.

These new results also have an important bearing on the situation that would arise in the event of nuclear warfare. If 3000 megatons of fission were detonated in the Northern Hemisphere, it is probable that, away from areas of local and intermediate fallout, the long-term strontium-90 level in the diet would reach about 180 micromicrocuries per gram of calcium, or an equilibrium bone level of about 45

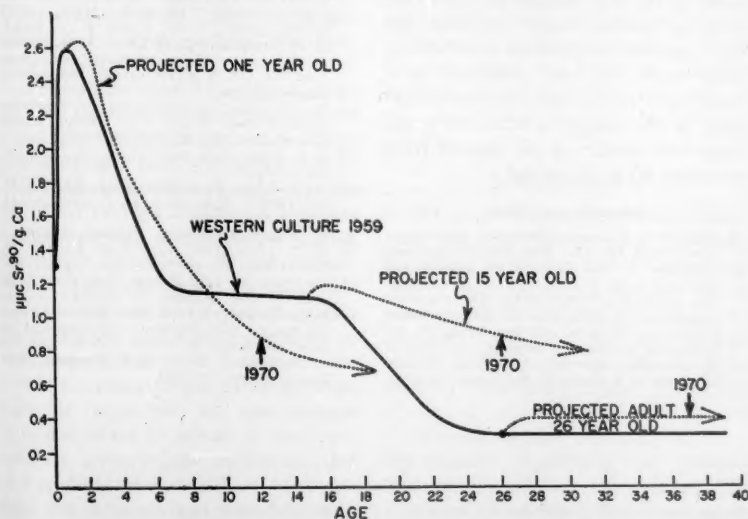


Fig. 3. Concentrations of strontium-90 in Western culture areas for 1959 and projected curves for individuals aged 1, 15, and 26 years, respectively, in 1959.

micromicrocuries. Thus, under these extreme conditions, the contamination of noncombatant areas would raise the average level of strontium-90 in the population to the point at which the bone dose from natural sources would be approximately doubled (26). Food grown in the area of intermediate fallout—a large portion of the United States—would yield an equilibrium concentration of strontium-90 in the diet in the range of 40 to 4000 micromicrocuries per gram of calcium; these concentrations would only produce bone levels up to the maximum permissible concentration for industrial workers even if no special measures were taken. Thus, long-term survival of large populations, even in the countries under attack, would appear to be feasible, provided the serious problem of short-term survival could be solved.

Conclusions

1) The strontium-90 concentration in human bone continued to increase in 1958 and 1959 but the concentration in new bone probably will reach a maximum in 1960.

2) The strontium-90 concentration in adult bone is independent of the age of the individual. The average for Western culture areas in the Northern Hemisphere in 1958 was about 0.20 micromicrocurie per gram of calcium, and in 1959, about 0.30 micromicrocurie.

3) The average strontium-90 concentration for the whole skeleton of an individual may be estimated from the analysis of a single bone to within 10 to 15 percent if sufficient activity is present.

4) The standard deviation for the strontium-90 concentration in fetuses or adults from a single metropolitan area is about 40 percent. The standard deviation for the average strontium-90 level in milk from several dozen stations in North America is also about 40 percent of the mean. These data permit an estimation of the distribution curve for 99 percent of the population of the United States.

5) The maximum strontium-90 concentration is now found in one-year-olds. In 1959 this average value was 2.1 micromicrocuries per gram of calcium for Western culture areas. The concentration varies markedly with age, in a predictable manner.

6) The discrimination factor from mother's diet to fetus appears to be about 12 against strontium as compared with calcium.

7) The strontium-90 level in persons who were one year old in 1959 will drop rapidly if there is no further atmospheric contamination. In 1970 these individuals will carry 0.9 micromicrocurie per gram of calcium.

8) The limited available data do not indicate any large difference in the distribution curves for rice-diet and Western culture areas. In a rice-diet area such as Thailand, however, the diet levels are approximately three times those in the United States per unit of fallout.

9) In general, because of differences in diet, strontium-90 concentrations in some tropical and Southern Hemisphere countries appear to be similar to concentrations in Western culture areas between latitude 30° and 70°N, despite the lower fallout rate in the tropics and the Southern Hemisphere.

10) Previous predictions of strontium-90 levels in diet and bone from tests to date have been high, due to overestimates of the stratospheric reservoir and the stratospheric residence time and an underestimate of the importance of the rate-of-fallout factor. Thus, the peak in the diet passed in 1959; the peak in growing bones will pass this year; and the equilibrium level will be lower than had been predicted by a factor of 5 to 10. This same factor applies to the long-term effect of a nuclear war insofar as the hazard from strontium-90 is concerned.

References and Notes

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Science in the News

The Antarctic Treaty: It Opens the Continent to Scientists of All Nations; Bars Military Bases

The Senate, by a vote of 66 to 21, has approved a 12-nation treaty which in effect internationalizes the continent of Antarctica. The treaty was proposed by the United States and signed by a dozen nations, including Russia, with scientific stations on the continent. Ratification by the Russians and five other nations yet to act was expected to follow closely the Senate action. The treaty bars all military activity on the continent and provides for unlimited aerial and ground inspection rights to accredited representatives of any nation signing the treaty. The entire continent, with a greater area than Europe and the United States combined, is open to all nations signing the treaty; no national claims of sovereignty to any of the continent's territory will be recognized. The principal, and at this date the sole, activity on the continent is scientific research. "For many, many years to come," the Foreign Relations Committee was told, "the principal export of Antarctica is going to be its scientific data. There is no single field of geophysics which does not demand for its completion data which can come only from Antarctica."

In recommending passage of the treaty the Foreign Relations Committee pointed out that it might set a pattern for future agreements on the international control of space. Of more immediate pertinence was that the treaty embodies, for the first time, several of the proposals that have stymied disarmament negotiations, particularly the right of inspection. No one supposes that the treaty is going to have immediate repercussions at Geneva, but it was felt that it would at least give both the Russians and ourselves some experience in what would be involved in a system of open inspection.

The immediate objective of the

treaty, though, has to do neither with disarmament nor with space. It was proposed by the United States as the only workable solution to the legal tangle that has existed in the Antarctic. Seven nations have made claims, most of them overlapping, to 80 percent of the continent. The United States, which appears to have the soundest basis for a claim on the basis of having made the earliest and most extensive explorations, has never made any claim. American policy, dating back to the 1920's, has been that no nation has the right to claim land its nationals do not occupy. Except for a few hundreds of scientists and supporting personnel, no one lives in Antarctica. We have therefore made no claim for ourselves and have refused to recognize the claims of other nations. The Russians, who also have some basis for a claim, based on what they insist was the sighting of the continent by a Russian ship in 1820, have taken substantially the same position as we have. Under the treaty the question of competing claims and possible claims is resolved by getting everyone to agree that no nation will insist on asserting national sovereignty over any part of the continent as long as the treaty is in effect.

Senate Discussions

The treaty was backed by the Pentagon, the State Department, the President, and both presidential candidates. But it was vigorously opposed by a minority in the Senate, predominantly Southern Democrats, but with enough others to form an unusual coalition ranging from fairly liberal Democrats (Gruening of Alaska and Engle of California) to the most conservative Republicans (Goldwater of Arizona and Bridges of New Hampshire). The two most conservative Democrats north of the Mason-Dixon line both spoke at length, Lausche of Ohio vigorously supporting the treaty and Dodd of Con-

necticut as vigorously opposing it. Bourke Hickenlooper (R-Iowa), who normally votes with Goldwater and Bridges, took the floor at the end of the debate to congratulate Chairman Fulbright of the Foreign Relations Committee for his masterful work in leading the supporters of the treaty and in turn was thanked by Fulbright for his excellent cooperation.

The opponents of the treaty stressed, above all, their displeasure that the United States should agree to international control of an area over which we might have asserted our national sovereignty. This gave an air of unreality to the debate. The supporters of the treaty repeatedly conceded that it was possible to argue that the United States made a mistake in 1924 in adopting the policy that no nation has a right to make territorial claims in Antarctica. But they said that even if we are convinced we made a mistake 36 years ago, it is still nothing but wishful thinking to assume we could now change our minds and expect that the Russians, in particular, would accept any claim we might make to exclusive control of Antarctica.

The opposition to the treaty had no effective answer to this. The opposition position was understandable, nevertheless, as a reflection of resentment of the view, held by most of the active supporters of the treaty, that the U.S. should be willing to accept the internationalization of Antarctica not merely as the expedient thing to do in this particular situation but as a desirable pattern for handling other international problems. The vote appeared to be a rough reflection of the division in the Senate between those who feel we can usefully try to resolve our differences with the Russians, and world problems generally, through international controls and those who feel that this is a dangerous illusion, who feel that any ceding of our powers to international groups, with the consequent restrictions on our national freedom of action, is probably a mistake.

The preliminary vote easily defeated (56 to 29) a motion to put off ratification until January, but this motion carried by less than the two-thirds margin that was necessary to approve the treaty itself. The vote that saved the treaty on the final roll call suggests that a number of senators were ready to vote for the treaty but would have preferred not to have to do so just before an election.

Senate Passes Appropriation Bill for the Atomic Energy Commission

The Senate passed an appropriation bill for the Atomic Energy Commission last week calling for \$2.7 billion for fiscal 1961. It added roughly \$17 million to the figure allowed by the House. This increase will be subject to a possible reduction when Senate and House conferees meet to work out the final version, although in any case the changes will amount to less than 1 percent of the AEC's appropriation.

The increase includes \$13 million for the Antarctic power reactors for which the AEC, under pressure from the Atomic Energy Committee, solicited bids a month or so ago, on the strength of assurances that money to pay for them would be added to the appropriation bill in the Senate (*Science*, 24 June).

Nuclear Aircraft

The Senate bill also removed a restriction the House had placed on spending for the controversial nuclear aircraft project. The AEC would like to spend about \$78 million on this project, \$15 million more than the House would have allowed. The nuclear aircraft project has become one of the most controversial scientific programs sponsored by the government. It is enthusiastically supported by the majority of the Atomic Energy Committee and by some elements in the Air Force and the AEC. Others, impressed by the apparent lack of results after an investment of nearly a billion dollars, are quick to call it a national scandal. One of the stories going around Washington, perhaps apocryphal, concerns a high-level meeting of scientists and administrators called to see how things were coming along. A leading expert on atomic reactors was present but had nothing to say until late in the afternoon, just as the meeting was breaking up. "But gentlemen," he asked, "how are you going to keep the plane from melting?" The meeting then continued another three hours without resolving this question.

AEC Chairman John McCone told the Appropriations Committee he thought the nuclear plane project was worth while. He said the limitation on spending should be eliminated because stretching the project out would only serve to make it just so much more expensive in the long run. The project, if it succeeds, promises to be extremely valuable. It will enable airplanes to stay aloft indefinitely, a military break-

through which the project supporters believe would be as important as the development of the nuclear submarine, with its ability to cruise indefinitely under water.

Other Programs

Larger but less controversial items in the AEC budget are for raw materials, nuclear materials (refined from raw materials), weapons, and the reactor development program. Each is budgeted at roughly half a billion dollars. The budget also includes about \$165 million for physical research and about \$55 million for biological and medical research.

Food and Drug Administration Tightens Regulations on Drugs

The Food and Drug Administration has proposed a general tightening of its regulations governing the brochures distributed by the drug companies with prescription medicines. The general effect of the proposals, which will become effective sometime this fall, is to require the manufacturer to include detailed information, including that on possible adverse side-effects, with almost all material sent by mail or distributed by the manufacturer's detail men when they call on doctors. Until now the manufacturer has been required only to include a notice offering to send doctors the detailed information on request.

The move is partly a reaction to Kefauver committee's criticism of the industry and of FDA's policing efforts. But the FDA began drafting the new regulations even before the Kefauver investigation got under way. According to a top FDA official, the investigation speeded the move, but the FDA had begun working on the proposed new regulations before the investigation began, in response to a changing attitude within the medical profession.

Attitude of the Profession

The FDA official said that the attitude of the profession, until fairly recently, was that the doctor did not need, and indeed would resent, any government action that might imply that a doctor needed the help of the government to assure that he learned all he should know before prescribing a new drug. It was the policy of the FDA, the official said, to respect this feeling on the part of the profession. But in

recent years, he said, the rapidly increasing number of new drugs introduced each year, accompanied by a heavy increase in promotional activity by the manufacturers, has led to a growing feeling in the profession that too many doctors, swamped by promotion and visits from detail men, were getting and relying on a one-sided picture of the unfamiliar drugs that the companies were recommending. The FDA has responded to this change in attitude by moving ahead with the new and tighter regulations.

In another move, again prompted in part by the Kefauver investigation, the FDA has proposed a procedure requiring the inspection of manufacturing procedures before a new drug may be placed on the market. The drug companies, like almost any other group, are less than delighted at these prospects of increased federal regulation, but judging by their initial reaction, they appear to regard the intent of the new regulations as reasonable. The net effect of the two moves is expected to go at least part way in achieving the objective of the drug manufacturer's licensing bill proposed by the Kefauver committee.

Pauling Hearing Postponed

Linus Pauling's reappearance before the Senate Internal Security Committee, originally scheduled for last week, has been postponed. Pauling had asked for a delay until November, but the committee ordered him to appear on 15 September. At that time he will have to risk a contempt citation if he maintains his refusal to supply the committee with the names of scientists who helped him gather signatures for a 1958 petition against nuclear testing (*Science*, 1 July).

Barring further postponements, there will be a showdown on 15 September unless a federal court upholds a petition Pauling has filed for an injunction against the committee's demand that he supply the names. If the court does not issue the injunction, which appears likely, and if Pauling and the committee both hold to their positions, he will presumably be cited for contempt. The courts will then have to decide whether the committee was justified in citing Pauling for contempt. (Whether the courts uphold Pauling's present request for an injunction will not necessarily indicate whether the contempt citation, if it comes, will be upheld.)—H.M.

News Notes

Instrument Capsule Recovered from Orbiting Discoverer XIII; First Balloon Satellite Launched

The United States has retrieved a 300-pound instrument capsule from an orbiting earth satellite, Discoverer XIII in the Air Force series. This is the first time a man-made object has been recovered from orbit, and the recovery represents a major step toward solving the problem of returning a man from space. The achievement also raises the prestige of the United States in foreign countries.

Discoverer XIII was launched into polar orbit on 10 August. On 11 August, on command from the ground, explosive bolts and springs released the capsule some 200 miles over the North Pole. The capsule orbited briefly until retrorockets broke its course and sent it back to earth, where it fell into the Pacific Ocean some 330 miles northwest of Honolulu and was hauled aboard a Navy helicopter.

Of 13 Discoverer satellites launched since March 1959, eight have gone into orbit. There have been six ejections of the instrument payload, but recovery attempts failed in every case. (One of the capsules is believed to have landed on the island of Spitzbergen, and there is speculation that it may have been found by the Russians.)

Now the Air Force reports that the chances of retrieving future capsules have increased to about 50 percent. Within a month an attempt will be

made to launch and recover a cabin containing a chimpanzee.

Communications Satellite Launched

A second major advance in space research also occurred on 11 August, when the National Aeronautics and Space Administration launched and successfully tested a balloon satellite, Echo I, as a mirror for radio waves. Folded in a 28-inch container, the aluminum-coated plastic balloon was sent aloft by a three-stage Thor-Delta rocket. Sublimating powders turned from solid into gas under the heat of the sun, and the gas inflated the balloon, which is 100 feet in diameter and is the largest, but not the heaviest, man-made object placed in orbit to date.

Echo I demonstrated its effectiveness almost immediately by reflecting a recorded message by President Eisenhower between stations in Goldstone, Calif., and Holmdel, N.J., a land distance of 2400 miles. It is hoped that not only messages but also television broadcasts can eventually be relayed across oceans by means of satellites.

Of all the satellites launched thus far, Echo is the easiest for ground observers to see. It will be in continuous sunlight for the next few weeks and is visible with the unaided eye as a bright star as it circles the earth approximately every 121 minutes. It is being seen in all countries between 47 degrees north and 47 degrees south latitude, which means that it is visible to most of the world's population. Dawn and dusk are the best viewing

times. Later the sphere will be in the shadow of the earth for varying intervals until next spring, when it will return to a period of full-time sun. It is expected to have a lifetime of about a year.

Wartime Reports Released

The Defense Department has declassified some 30,000 technical reports, the work of the wartime Office of Scientific Research and Development that was headed by Vannevar Bush. The material was prepared by British and Canadian, as well as American, scientists. It covers such areas as proximity fuses for explosives, guided bombs, range finders, metallurgy, radar, communications, chemical warfare, and rocket ordnance. The information that is being released has been in classification categories that ranged from "Confidential" to "Secret." "Top Secret" material is to remain classified.

By 1 September the Library of Congress will be prepared to make the material available to the public through its Science and Technology Division. The Commerce Department's Office of Technical Services will offer copies of the reports for sale.

United States and Canada Plan Expanded Reactor Program

Atomic Energy of Canada Limited and the U.S. Atomic Energy Commission have signed a memorandum of understanding that establishes an expanded program of cooperation in the development of heavy-water-moderated power reactors. The new agreement provides for the exchange of detailed information, close cooperation in research and development, exchange of personnel, mutual use of pertinent research and development facilities, and the transfer of certain materials.

The program also includes the undertaking in the United States, by the commission, of research and development work that will be specifically directed toward design of the heavy-water reactors to be constructed by Canada. This work may extend over a period of 5 years, at a maximum total cost to the United States of \$5 million.

A joint technical board is being established to advise Atomic Energy of Canada Limited and the U.S.

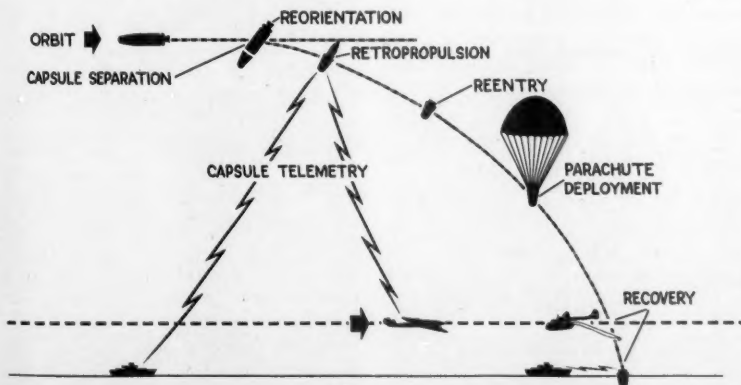


Diagram of the steps involved in bringing the Discoverer XIII capsule to earth. As it circled in a tail-first position, the satellite (upper left) tilted 60 degrees, nose down. The capsule was separated by springs and explosive bolts. A retrorocket was fired to slow it down from 18,000 miles an hour, permitting it to follow a curved path toward the earth. Airplanes and ships followed its path (by telemetry). A parachute opened to further reduce speed. Aerial recovery failed, and a helicopter from a patrol ship made the recovery.

Atomic Energy Commission on the over-all progress of the cooperative program and on future requirements to meet its objectives.

Unusual Pueblo Indian Image Found

An unusual sacred image, the first of its kind ever to be unearthed, has just been discovered at a site near Vernon, Ariz., by the Chicago Natural History Museum's Southwest Archaeological Expedition. The figure was important in the religious ceremonies of Pueblo Indians living in Arizona between A.D. 1250 and 1350.

Paul S. Martin, the museum's chief curator of anthropology, reports that the stone image, very possibly a katchina, was found in a secret crypt within one of the largest rectangular kivas, or religious ceremonial chambers, ever excavated in the Southwest. He comments:

"This may well be one of the important discoveries of the 20th Century in Southwestern archaeology. To my knowledge, no one has ever before found a katchina of either wood or stone in a kiva. As far as I can determine, the image is unique." This is the fifth season in which Martin has conducted archeological work near Vernon for the Chicago museum.



Copy of the sacred stone image found in a secret crypt of a Pueblo Indian kiva, being excavated by Chicago Natural History Museum archeologists near Vernon, Ariz. The right arm, which in the original was found broken off, has been restored. [Chicago Natural History Museum]

Present-day Hopi Indians carve wooden katchina figures to represent various deities, and use them in the religious education of their children. But while the figures are more than playthings, they are not, in themselves, sacred. However, masks and other paraphernalia worn or carried by men who impersonate the katchina deities are extremely sacred and are stored in kivas when not in use. The fact that the stone katchina image was hidden in a secret masonry vault within an unusually large kiva suggests that this image was believed to possess godlike sacredness and power in its own right.

The figure, 9 inches high, is carved in sandstone and painted black, orange, green, and blue. The right arm had been broken off and was not found in the crypt, perhaps indicating that it was broken intentionally in order to curtail the powers of the katchina when the Indians who used the kiva moved away from the pueblo. With the image in the foot-square stone vault was a tiny jar, painted with red and black crosses, that contained a few beads of stone, shell, jet, and turquoise.

The crypt in which the religious objects were found appears to duplicate on a small scale the architecture of the great kiva itself. It has been suggested that the crypt may have symbolized the entrance to the underworld. According to the religious belief of the Hopi Indians, it was through such a passage that their ancestors emerged into the world from their place of origin in the underworld. Thus, the stone figure may be related to "underworld" ceremonies that are still a part of the religion of the Hopi people today.

Grants, Fellowships, and Awards

General. The American Academy of Arts and Sciences invites applications for grants from its research funds. Awards are made in support of research in any field of science whatsoever, in amounts that ordinarily do not exceed \$1500. Applications for grants to be made in the fall should be filed by 25 September on forms that may be obtained from the Chairman, Committees on Research Funds, American Academy of Arts and Sciences, 280 Newton St., Brookline 46, Mass.

Special consideration will be given to projects in new frontiers of science; those that lie between, or include, two or more of the classical fields; and those proposed by investigators who may be

on the threshold of investigational careers or who are handicapped by inadequate facilities. The committees do not provide fellowship or scholarship support, nor do they ordinarily approve grants for research the results of which constitute partial fulfillment of requirements for an academic degree.

Infectious microorganisms. The U.S. Army Chemical Corps Biological Laboratories, Fort Detrick, Frederick, Md., has announced initial awards under a new grant program planned to support basic scientific research. Areas of investigation under consideration for support include the genetic, biochemical, and physiological characterization of infectious microorganisms, the host-parasite relationship in airborne infection, and medical entomology.

Laboratory construction. The National Science Foundation has announced that the next closing date for receipt of proposals for support of renovation or construction of graduate-level research laboratories is 1 September. Proposals received by that date will be reviewed during late fall and early winter. Disposition of approved proposals will be made during early spring, 1961.

This program will continue to require at least 50 percent participation by the institution with funds derived from nonfederal sources. Proposals may be submitted for modernization or construction of research laboratories, including laboratory furnishings but not including apparatus or equipment, in any field of the natural sciences. For the present, this program is restricted to those departments which have an on-going program leading to the Ph.D. Support of facilities to be used primarily for instructional purposes will not be considered. For information, write to the Office of Institutional Programs, National Science Foundation, Washington 25, D.C.

Scientific information. The National Science Foundation has announced that it will consider proposals during the current fiscal year for additional research projects or studies of a fundamental or general nature that may produce new insights, knowledge, or techniques applicable to scientific information systems and services. Although the foundation will consider any proposals for a project that may contribute to the general goal of improving the handling of scientific information, the following research areas are of the greatest interest at present: (i) information needs of the scientific com-

munity; (ii) information storage and retrieval; (iii) mechanical translation. Address inquiries and proposals to: Documentation Research Program, Office of Science Information Service, NSF, Washington 25, D.C.

News Briefs

Soviet Friendship University. The U.S.S.R.'s new Friendship University for young people from Asia, Africa, and Latin America has received more than 4000 applications. The university is to open in Moscow at 5 Duns kaya Street on 1 October. Classrooms and dormitories will be located in a single large building.

The entire course of training will be free, and the university will even pay the students' return fares. In addition, all students will receive a stipend and enjoy free medical services. An initial group of 500 has been accepted for the fall opening. In time, from 4000 to 5000 students are expected to enroll.

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Medical school enrollments down. For the third consecutive year, the number of individuals applying to United States medical schools has decreased. The number of medical-school applicants for the 1959-60 academic year was 6 percent less than the number applying in 1956-57. The over-all number of acceptances increased slightly (up to 3 percent over 1956-57), thereby accentuating the significance of the trend in enrollments.

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Reactor guide. The Atomic Energy Commission has published a 34-page literature search, *Selected Reactors of the Power Reactor Demonstration Program*, which is available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C., for 75 cents. The bibliographical listing gives the title, author, publication date, price, and availability source for 314 reports about ten power reactor projects under construction or planned.

* * *

Cell biologists organize. A group of cell biologists has organized a new society, the American Society for Cell Biology, to further the development of cell biology and to improve communication among scientists representing diverse disciplines. Membership is expected to include biochemists, biophysicists, cytologists, histologists, microbiologists,

physiologists, and others interested in the cell.

Persons having educational or research experience in this area and desirous of joining the new organization should request application forms from Dr. Montrose J. Moses, Box 2982, Duke University School of Medicine, Durham, N.C. Membership is not restricted to residents of the United States.

The 21-member organizing group, which first met in New York last January, constitutes the provisional council. The first annual meeting of the society will be held in October of 1961.

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Retirement credit for officers. U. S. Army reserve officers may obtain retirement point credit for attending specified symposium sessions of the fifth International Congress on Nutrition, to be held in Washington, D.C., 1-7 September. The sessions designated are "Evaluation of nutritional status in man," "Effects of processing and additives on foods," "Lipids in health and disease," "Animal nutrition and food production," "Nutrition in maternal and infant feeding," "Proteins and amino acids in nutrition," "Three hours around the world—new possibilities in nutrition research," and "World food needs and food resources." Lt. Col. Ernest M. Parrott has been appointed military chairman. He will have a registration book available near the entrance to the program session room.

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Radiation and the nervous system. The first international symposium concerning the effects of radiation on the nervous system will be held 7-9 September at the Northwestern University Medical School in Chicago. The meeting is sponsored by Northwestern under grants from the U.S. Public Health Service and the U.S. Atomic Energy Commission.

Russian scientists, as well as scientists from Europe, North and South America, and Japan, will participate in the conference. Some 44 research reports will be presented.

* * *

Molecular structure. A conference on Molecular Structure and Organic Reactions, to be held 7-9 November in Houston, Tex., under the sponsorship of the Robert A. Welch Foundation, will attract approximately 600 scientists from all over the world. The principal speakers will include the following distinguished visitors from abroad: Vladimir Prelog, Laboratorium für Organische Chemie, Zürich, Switzer-

land; R. Huisgen, Universität München, München, Germany; J. Monteath Robertson, University of Glasgow, Glasgow, Scotland; and Derek H. R. Barton, Imperial College, London.

* * *

Nuclear structure conference. The 1960 International Conference on Nuclear Structure will draw some 400 nuclear scientists to Queen's University, at Kingston, Ontario, Canada, 29 August to 3 September. Delegates from at least 24 countries are expected to attend, including about 150 from various laboratories in the United States and 80 from those in Canada. The U.S.S.R. has signified its intention of sending a large delegation which will include some of the principal speakers.

The sponsors of the conference are the International Union of Pure and Applied Physics and several Canadian organizations. The conference president is W. B. Lewis, Atomic Energy of Canada Limited, and the vice-president is V. F. Weisskopf, Massachusetts Institute of Technology.

* * *

Tropical dermatologists organize. The inaugural meeting of the International Society of Tropical Dermatology was held this spring at the Rockefeller Institute, New York. More than 230 persons attended, including several representatives of federal and state governments, members of the diplomatic corps, and visitors from foreign countries. Aldo Castellani is the president of the new organization, and Frederick Reiss is secretary general. Some 50 countries are represented in the society, which has 1300 charter members. The first international congress will be held in either 1962 or 1963.

* * *

Biologists meet. Biologists from laboratories and scientific agencies in every part of North America and 11 foreign nations will gather at Oklahoma State University, from 28 August to 1 September, when 20 biological societies will meet jointly under the sponsorship of the American Institute of Biological Sciences. More than 3500 scientists will attend. Some 1235 technical papers will be presented, and as many as 23 sessions will be conducted simultaneously.

James G. Dickson, professor of plant pathology at the University of Wisconsin, is president of the 85,000-member institute. The meeting is the first for the AIBS and its member societies to be held in the Southwest.

Scientists in the News

Vladimir V. Belousov of the Soviet Union has been elected president of the International Union of Geodesy and Geophysics, which recently ended a 2-week conference in Helsinki. Belousov succeeds **J. Tuzo Wilson** of the University of Toronto. **Joseph Kaplan** of the University of California and **Julius Bartels**, a West German, were elected vice presidents.

With the election of Belousov, Russians head two of the international organizations concerned with space research. The other is the International Astronautical Federation, whose president is **Leonid I. Sedov**. The federation opened its meeting in Stockholm on 15 August.

Larkin H. Farinholt, for the past 2 years deputy science adviser to the Secretary of State, has been appointed administrator of the Alfred P. Sloan Foundation's \$1-million-a-year Program for Basic Research in the Physical Sciences. He succeeds **Richard T. Arnold**, the first administrator of the Sloan program, appointed in 1955. Arnold has recently accepted the position of director of research with Mead Johnson and Company.

The first **Henry Bryant Bigelow** Medal for oceanography has been awarded to the man it honors. Paul M. Fye, director of the Woods Hole Oceanographic Institution, presented the award to Bigelow at a surprise luncheon ceremony on 10 August during the annual meeting of the corporation and board of trustees of the institution.

Bigelow was among the founders of the Oceanographic Institution. He was its first director, served later as president of the corporation, and is now chairman of the board of trustees. He is also professor emeritus of zoology at Harvard University, having taught there for nearly half a century, and is a research oceanographer and former curator of the Museum of Comparative Zoology at Harvard.

The Bigelow Medal, which is accompanied by a \$2500 cash prize, was established earlier this year by the trustees of the Oceanographic Institution without the knowledge of their chairman.

Arne Engström, distinguished biophysicist and head of the Division of Medical Physics at the Karolinska In-

stitute in Stockholm, will spend 6 months as visiting professor of medical physics at the Donner Laboratory of the University of California, Berkeley, starting in the fall semester.

Merrill M. Flood of the University of Michigan, professor of industrial engineering in the College of Engineering and senior research mathematician in the Mental Health Research Institute, has also been appointed professor of mathematical biology in the department of psychiatry of the Medical School.

Fred L. Mohler, chief of the mass spectrometry section of the National Bureau of Standards, has retired from active service after 43 years with the bureau. Mohler received his Ph.D. in physics from Johns Hopkins University in 1917. He joined the Atomic Physics Section at NBS the same year and was made chief of the section in 1928. During this period he worked on fundamental phenomena in atomic physics, including electrical discharges in gases, the study of ionization potentials, and ionization of liquids. Later, after a year with the Manhattan Project, Mohler was appointed chief of the Mass Spectrometry Section, where he has been engaged in the development of mass spectrometric methods as applied to chemical and isotope analysis and molecular physics.

Charles W. Mattison, head of the education branch of the U.S. Forest Service's Division of Information and Education, has retired after more than 30 years with the Forest Service. He will remain in the conservation-education field on a part-time basis, organizing and conducting a program for the American Forestry Association.

His successor is **Matthew J. Brennan**, who joins the Forest Service from the Department of Health, Education, and Welfare, where he has been employed by the science, mathematics, and foreign-language section of the Office of Education as specialist for elementary science.

The Helen Hay Whitney Foundation has announced that **Rebecca C. Lancefield**, member and professor of the Rockefeller Institute, will receive the third T. Duckett Jones Memorial Award. The \$6500 award will be presented to Dr. Lancefield on 8 October at a dinner to be held in her honor at the Princeton Inn, Princeton, N.J.,

during the foundation's third annual meeting of research fellows and second Connective Tissue Conference.

Dr. Lancefield is being honored for extensive and fruitful investigations of the biology of hemolytic streptococci. Her discoveries have led to better understanding of streptococcal infections and their two most important sequelae—rheumatic fever and acute glomerulonephritis.

Robert H. Randall retired from the federal service on 11 July and is now vice president of the Aero Service Corporation of Philadelphia. During his service in government he has been a member of the National Academy of Sciences' Committee on Organization of Federal Government Surveying and Mapping; consultant to the National Resources Planning Board on State and Regional Planning, Public Works, and Urbanization; consultant on surveys and maps, Tennessee Valley Authority; U.S. member of the Committee for Public Works Planning of the International Labor Organization; and assistant on cartography with the U.S. Bureau of the Budget, Executive Office of the President.

Ruby K. Worner, textile technologist and head of product evaluation investigations of the U.S. Department of Agriculture's Southern Utilization Research and Development Division, has received a Fulbright grant for study at the University of Alexandria, Alexandria, Egypt, for the academic year 1960-61. She will be a lecturer and consultant in textile technology and research, with special reference to cotton.

John S. Griffith of the department of theoretical chemistry at Cambridge University has been appointed professor of chemistry at the University of Pennsylvania.

Alan W. Donaldson, assistant chief of the U.S. Public Health Service's Communicable Disease Center at Atlanta, Ga., has been named deputy chief. He succeeds **C. A. Smith**, who was promoted from deputy to chief on 1 July.

Andrew Gemant, research scientist and staff physicist for Detroit Edison's engineering research department, has retired after 20 years of service with the company. Gemant has won distinction for his basic research on the phys-

ical chemistry of insulating materials. He has written four physics books and more than 160 papers on various subjects, including colloid chemistry, high-voltage physics, electrochemistry of hydrocarbons, and radioactive tracers.

Two appointments at the University of Pennsylvania School of Medicine have been announced.

Harold G. Scheie, professor of ophthalmology, has been named chairman of the department of ophthalmology, and **Harold S. Ginsberg** of Western Reserve University School of Medicine, Cleveland, has been named professor and chairman of the department of microbiology.

Scheie succeeds **Francis H. Adler**, who will become emeritus professor of ophthalmology after 23 years as department chairman.

The Robert A. Welch Foundation, Houston, Tex., has announced that five well-known scientists have been selected under the foundation's competitive Visiting Scholar Program, which makes awards that range from \$12,000 to \$20,000 per academic year. The recipients chosen are as follows:

Edward Teller, nuclear physicist and professor at the University of California at Berkeley, who will visit the Rice Institute during the spring of 1961.

Daniel Bovet, Nobel laureate in physiological chemistry and a professor at the University of Rome, who will visit the Southwestern Medical School in Dallas during the 1960-61 academic year.

Hans Jonassen, professor of chemistry at Tulane University, who will visit the University of Texas in Austin during the 1961-62 academic year.

M. D. Taylor, professor of chemistry at Howard University, who will visit Prairie View Agricultural and Mechanical College during the 1960-61 academic year.

W. B. Smith, professor of chemistry at Ohio University, Athens, who will visit Texas Christian University during 1960-61.

Herbert B. Pahl, formerly assistant professor of biochemistry at Vanderbilt University School of Medicine, has been appointed executive secretary of the Biochemistry Training Committee in the Division of General Medical Sciences of the National Institutes of Health. He succeeds **George M. Briggs**, who has accepted a professorship at the University of California, Berkeley.

At the California Academy of Sciences, San Francisco, **Joel F. Gustafson** has been named associate director; **Robert C. Miller**, director, has been given the additional appointment of curator of the department of invertebrate zoology, of which **Allyn G. Smith** has been named associate curator of the academy.

Arthur Rose has asked to be relieved of instructional duties as professor of chemical engineering at Pennsylvania State University in order to direct the revision of the Condensed Chemical Dictionary and Distillation Literature Index and Abstracts. In addition, he wishes to engage more fully in work at Applied Science Laboratories, Inc., State College, Pa., on a freezing process for saline water demineralization and on preparation of high-purity fatty acid standards for lipid chromatography. Rose will continue to direct his graduate research program at the university.

H. Willard Davis, principal scientist with the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn., has resigned that position to return to the University of South Carolina, from which he was on leave of absence as head of the department of chemistry. The university has recently announced his promotion to the post of dean of the College of Arts and Science.

Recent Deaths

Pio Bianco, Buffalo, N.Y.; 68; nationally known orthopedic surgeon who was a professor of orthopedic surgery at the University of Buffalo Medical School for 20 years, until his retirement in 1950; 9 Aug.

Bernard O. Dodge, New York, N.Y.; 88; specialist in plant diseases and the genetics of fungi; plant pathologist at the New York Botanical Garden for 20 years, until his retirement in 1957; his pioneering work in the experimental breeding of fungi is credited with having led to a better understanding of the nature of heredity and inherited characteristics; 9 Aug.

Heinrich Hauptmann, São Paulo, Brazil; 55; professor of organic chemistry and head of the department of chemistry of the Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo; 21 July.

Francis A. Jenkins, Berkeley, Calif.; 61; professor of physics at the University of California and a pioneer re-

searcher in molecular spectroscopy; 3 Aug.

William G. Lennox, Boston, Mass.; 76; authority on epilepsy, whose latest book, a two-volume work entitled *Epilepsy and Related Disorders*, was published last month; associate professor of neurology at Harvard Medical School until 1954; was chief of the seizure division at the Children's Medical Center in Boston, where he established an epilepsy training program for physicians; was former president of the International League Against Epilepsy and organized the American Epilepsy League; 21 July.

Walter F. Loehwing, Iowa City, Iowa; 63; botanist and dean of the State University of Iowa graduate college; a member of the faculty for 35 years, including 13 years as head of the botany department; 1 Aug.

James Lunny, Colonia, N.J.; 38; Weather Bureau meteorologist stationed at New York International Airport, Idlewild, Queens; 8 Aug.

Nikolai Shatsky, Moscow, U.S.S.R.; 64; geologist; since 1934 head of the Institute of Geology of the Soviet Academy of Science; specialist in tectonics; Stalin prize winner; 2 Aug.

F. Lee Stone, Chicago; 75; executive director of the Cancer Prevention Center of Chicago; associate professor emeritus of obstetrics and gynecology at the University of Illinois College of Medicine; 1 Aug.

Percival M. Symonds, New York; 67; psychologist and professor emeritus of education at Teachers College, Columbia University, who devoted his career to research in educational methods, with particular attention to the psychology of teacher-child and parent-child relationships; had just completed a book, *From Adolescent to Adult*; 6 Aug.

Oswald Veblen, Princeton, N.J.; 80; mathematician who was internationally known for his contributions in geometry, particularly in analysis situs; Fine professor of mathematics at Princeton University from 1910 until his retirement from the university in 1932; then the first professor of mathematics at the Institute for Advanced Study in Princeton and, in 1950, a professor emeritus; 10 Aug.

Ivan Yakushkin, Moscow, U.S.S.R.; 74; internationally known agronomist who was the author of more than 260 books, pamphlets, and articles on increasing yields of field crops; had been teaching at Moscow Agricultural Academy since 1932; 20 July.

Book Reviews

The Main Characteristics of the Structure of China: Preliminary Conclusions. *Scientia Sinica*, vol. 9, No. 4, pp. 492-544. T. K. Huang. Academia Sinica, Peking, China, 1960.

This article, published by the Academia Sinica, is a progress report on a subject to which the author made important contributions before 1950. As the magazine, *Scientia Sinica*, seems to be available in only a few libraries in the United States, American scientists would be interested in having more such articles reviewed in *Science*.

In a brief introduction the author comments on the progress of geological research in China during the last century, alluding to books by J. S. Lee, Huang, and Chang. At somewhat greater length he deals with progress since 1949. This section ends with the significant statement: "imbued with the policy of 'letting a hundred flowers blossom, and a hundred schools of thought contend' as put forth by Chairman Mao Tze-tung and supported by the tectonic map of China just compiled, we feel we have courage enough to present in this article our preliminary conclusions and viewpoints to serve as a basis for future discussions among geologists at home and abroad."

Next the author describes and interprets the geology of China by regions. He divides the entire country into two parts—Eastern China, which is called the Chinese Platform, and the Western Folded Regions. In the former the author recognizes 15 major units (called *paraplatforms* and fold systems), comprising 69 subdivisions, each of which is described in as much detail as space permits. In discussing the individual regions, the author notes that information about the geologic structure of some of them is still scanty (for example, Tibet). The accompanying index map shows Tibet and Taiwan (Formosa) as parts of China; however, the geology of Taiwan is dismissed in two lines. Reference is made in the

article to a tectonic map of China recently published, and the author indicates that another map, on a slightly larger scale (1:3,000,000), is now being compiled. Again, American scientists would welcome an opportunity to have review copies.

In the second section of the paper, the geological history of China is discussed with special reference to structure, orogenies, and sedimentary cycles.

Seven topics are singled out for discussion in this part of the paper: (i) "The Indosinian cycle of movements and its identification"; (ii) "the Yenshanian cycle of movements and its importance"; (iii) "polycyclic orogeny and polycyclic magmatic activity"; (iv) "deep faults and great faults"; (v) "origin and development of big uplifts and big depressions"; (vi) "the paraplatform and its characteristics"; and (vii) "certain characteristics of the geosynclinal regions of China."

Of these the Yenshanian cycle affects almost all of China and is, therefore, treated at greatest length. The author concludes that Chinese geosynclinal regions are different from those in other parts of the world, and he enumerates five contrasting points.

In this section of the paper, it is not always easy to distinguish between fact and the author's opinion. The reader may be unable to evaluate many of the assertions, which have been made with apparent confidence, about correlations, events, and classification. He will also encounter a rather large number of unfamiliar terms, some of which have been introduced in this article—for example, *paraplatform* and *orthoplatform*, as well as a distinction between "deep faults" and "great faults."

An unusual feature of this paper is the treatment accorded previous workers in the same field. There is no terminal list of references, and there are but few specific citations to any earlier papers, even those which are casually mentioned in the text. The author

seems to depreciate or ignore the work of most of his predecessors, especially that of foreign geological explorers of China. Although the work of J. S. Lee is commended, there is no mention of the important and extensive writings of Grabau, Wong, and others. There is, however, occasional mention of the ideas of "some geologists," but they are not named.

American readers will observe, perhaps without much surprise, an ideological slant here and there, especially in the introduction. Up to about 1949, scientific papers by Chinese geologists were as free from such political taint as those of their co-workers in the Free World. This was also quite as true of Huang's earlier writings. The paper here reviewed paints a sad picture of the plight of Chinese scientists before "the Liberation" and contrasts with it the rapid progress made since 1950 under "the brilliant leadership of the Chinese Communist Party." There is even a complimentary reference to "the big leap forward in industrial and agricultural spheres in 1958," which the author says was accompanied by a big step forward in geological work. Generous praise is rendered to the current régime in Peking for promoting geological research.

In a footnote it is stated that this paper was published in Chinese a few months earlier and has been translated into English by Comrade Wei of the Geological Library; apparently Wei is not as competent in English as Huang himself is well known to be. Perhaps some of the peculiarities mentioned above have been introduced in the final process of translation and editing.

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The 1956 Presidential Campaign.

Charles A. H. Thompson and Frances M. Shattuck. Brookings Institution, Washington, D.C., 1960. xv + 382 pp. \$5.

Future generations of scholars may well know more about the presidential candidates and campaigns of the 1950's than about the comparable personalities and events of any previous epoch in American history. And a substantial portion of the credit may be given to the Brookings Institution and the series of volumes which was inaugurated with the massive *Presidential Nominating*

Politics in 1952. The latest addition to the Brookings political shelf is of modest proportions compared with most of its companions, but its contribution to our knowledge of presidential politics can scarcely be measured on this dimension. In *The 1956 Presidential Campaign*, Charles A. H. Thompson and Frances M. Shattuck have compiled an excellent summary of the major public events which preceeded the re-election of President Eisenhower.

Even the casual citizen must be impressed, if not overwhelmed and dismayed, by the complexities and confusion of presidential politics. The amateur pundit along with the serious student of American politics will appreciate the order and coherence which Thompson and Shattuck bring to their subject. Without omitting any of the major phases of the campaign, they have distilled, summarized, and condensed to present a well-paced account, extending from the election of 1952 through the repeat performance 4 years later. The result is true to the authors' explicit promise, in the preface, "to do a history of a political campaign."

It is less clear that this very readable volume redeems the implied concern, also voiced in the preface, for rigorous analysis of human behavior. Of the many aspects of political behavior, the antics and aspirations of presidential politicians are probably among those least amenable to analysis in terms of the various elegant models now being put forth for the study of decision-making or other phases of elite politics. *The 1956 Presidential Campaign* may provide case material and illustrations for theoretical speculation and generalization, but its major contribution is more likely to be appreciated by the reader interested in contemporary political history.

The professional scholar may be somewhat irritated by the authors' selection of footnotes. Frequently the most public and widely known events are described and then carefully attributed to the *New York Times*, while events not recorded by the journalists and interpretations obviously based on little known fact are presented without documentation. Both the scholar and the amateur politician may detect an occasional overtone of partisanship in the authors' choice of words and emphasis. One would guess that Thompson and Shattuck are either Stevensonian Democrats or else a pair of badly over-compensating followers of Mr.

Nixon. It may be only this reviewer who thinks that extended direct quotations of Mr. Eisenhower's informal remarks are a disingenuous form of unsympathetic criticism (see, in particular, page 278), but the use of a subtitle such as "Nixon's many masks" (page 289) is less open to interpretation.

Such minor cavils should not obscure my sense of the many good qualities of the book. It provides a most useful chronicle of the events of the campaign. It also records the most important facts of convention and election, with detailed presentation and some analysis of the votes cast in each. Finally, *The 1956 Presidential Campaign* captures the full spirit of its subject for future generations who will have forgotten, or never have experienced, the delight and the despair of the second Eisenhower-Stevenson contest.

WARREN E. MILLER

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Automation and the Worker. A study of social change in power plants. Floyd C. Mann and L. Richard Hoffman. Holt, New York, 1960. 272 pp. \$4.50.

A power company built a new automated plant, "Advance," in a rural town. Elaborate questionnaires were given workers in Advance and in one of the older plants, "Stand." This text presents and interprets some hundred tables of comparative data obtained from these questionnaires.

Many variables made it difficult to create a reliable research design. The plants differed in managerial climate, work-force characteristics, and other nontechnological respects. The fact that there were fewer supervisory levels at Advance appeared to increase the status of the foremen and to improve communications.

Most workers at Advance had been promoted from older plants to jobs with enlarged responsibility, more prestige, improved working conditions, and higher wages. It was hardly surprising to find that workers at Advance had increased job interest and job satisfaction; since management was "paying attention" to Advance, the discovery of lowered job satisfaction at Stand might also have been expected.

Advance was not without its own problems. The pressure of management for early results increased work tension.

The interdependence of operations required centralized maintenance, which aroused conflict. The workers were dissatisfied with second and third shift arrangements. There is a full chapter, "Continuous operation; patterns and effects," which highlights the shift problem as a generally unsolved issue with which all management must become concerned. The increased capital investment per employee in automating production or data processing will inevitably increase the number of companies and human beings affected by shift work.

For companies about to introduce new processes, Mann and Hoffman suggest a conceptual viewpoint which anticipates effects on the total organization, not merely on the point of change; which recognizes that people do not adapt quickly to new problems or new skills; and which recasts traditional training methods to develop intellectual, rather than motor skills, as well as greater understanding of the role each new job plays in the interrelated production complex.

The authors concede that the effect of technical changes on the social system is not a new concept, but state that "planning continues to focus on engineering design and to ignore the psychological and sociological factors."

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An Introduction to Kansas Archeology.

Waldo R. Wedel. With a "Description of the skeletal remains from Doniphan and Scott counties, Kansas," by T. D. Stewart. (Bureau of American Ethnology, Bulletin 174.) Smithsonian Institution, Washington D.C., 1959. xvii + 723 pp. Illus. \$3.

Although titled "an introduction," this monumental volume is the most complete archeological synthesis yet made for any state in the union. Its author has worked on the archeology of the Central Plains for nearly 30 years; for most of that time he has been its most outstanding authority. The present volume is based on Wedel's field work in Kansas during 1937, 1939, and 1940 for the U.S. National Museum; but in order to make the record for the state as complete as possible, he has compiled numerous bits of evidence from now-obscure sources reaching back into the 19th century, on the one hand,

and from work done by himself and others since 1940, on the other. The result is a beautifully organized and complete record, with the original data clearly separated from the author's scheme of interpretation.

Wedel is more than a supremely competent archeologist; he is one of the rare students of the interrelationships of man and environment who can separate fact from fancy. Beginning with a study of natural environment and climate in Kansas, he proceeds to a thorough examination of documentary data on the known tribes of Kansas: the Kansa, Osage, Pawnee, Wichita, Plains Apache, Kiowa Apache, Kiowa, Comanche, Cheyenne, Arapaho, and Padouca. In historic times some of these tribes were purely bison hunters, some were agriculturalists, and some combined these economies. As in most parts of the United States, it is difficult to relate certain tribes to the archeological past, but Wedel handles these problems with his usual consummate skill.

Thus, whether the author is discussing the purported association of artifacts with the Pleistocene fauna at Russell Springs, the ceramic or agricultural complexes which may be related to eastern "Woodland" cultures, or the problems of identifying historic "Quivira" and "El Cuartelejo," we see the same careful sifting of evidence and lucidly stated opinions, not to mention his greatly detailed descriptions of the sites he personally excavated.

ALEX D. KRIEGER

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Information Processing. Proceedings of the International Conference on Information Processing, UNESCO, Paris, 15-20 June 1959. Oldenbourg, Munich; Butterworths, London, 1960 (order from UNESCO Publications Center, New York). 520 pp. Illus. \$25.

This conference, the first international conference devoted to information processing, was sponsored by UNESCO, and it brought together approximately 2000 experts on computers and information processing, representing 39 countries. Howard Aiken, the director of the computation laboratory at Harvard University, was president of the conference; Pierre Auger served as the secretary-general.

The papers and symposia at the conference were on subjects in the following categories: methods of digital computing; a common symbolic language for computers; automatic translation of languages; pattern recognition and machine learning; logical design of computers; and computer techniques of the future.

PHILIP RABINOWITZ

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Washington, D.C.

The Biology of Marine Animals. J. A. Colin Nicol. Interscience, New York, 1960. xi + 707 pp. Illus. \$14.

Although the theme of this book is ecological, its content is mainly physiological. It is concerned with the physiology of the solutions made by marine animals to the problems presented by their environment.

The introductory chapter summarizes the properties of the marine environment which impinge upon vital processes. Most of the others deal with comparative physiology and, in arrangement and content, resemble Prosser's *Comparative Animal Physiology*. The two books have eight chapter titles that are almost identical.

Water, ions, and the *milieu interne* are taken up first, then respiration and digestive functions. Here, for example, although there is overlap with Prosser, Nicol's emphasis is more on feeding mechanisms and functional morphology, less on enzymes and intermediary metabolism.

A long section of three chapters is devoted to sensory physiology, transmission, and effector mechanisms. Pigments, color change, and bioluminescence are treated in the next three chapters.

Chapter 14 departs from comparative physiology to deal in a well-rounded way with associations. These are categorized as commensalism, symbiosis, and parasitism, but Nicol emphasizes that these are stages in a spectrum of relationships between closely associated organisms.

Finally, an account of skeletons, shelters, and special protective mechanisms is given. Here as elsewhere the discussion is in a phylogenetic framework which does not discriminate against marine vertebrates other than fishes.

All of the chapters are well docu-

mented reviews. References, mainly through 1956, are conveniently grouped with each chapter and occupy 80 pages or 12 percent of the book. A sample of 200 revealed 84 percent to be in English and 70 percent to be from British or American sources; only 1.5 percent were from the Japanese literature.

Specialists will doubtless find their own research areas slighted in favor of less exciting aspects of marine zoology. However, Nicol has attained a commendable balance of the various ecological aspects of comparative physiology; and the coverage conveys the fascination of observation and experiment to those for whom the book is mainly intended—young biologists making their first serious excursion to the sea and undergraduates specializing in marine zoology. However, even the brighter among these readers will find the book meaty. Knowledge of comparative morphology and general biology are expressly presumed, and some familiarity with the generic names of the better known invertebrates is helpful.

ALAN J. KOHN

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Florida State University

The Story of Engineering. James Kip Finch. Doubleday, Garden City, N.Y., 1960. xxvii + 528 pp. Illus. \$1.45 (\$1.65 in Canada).

The increasing popularity of books dealing with the history of engineering and technology is pointed up by the appearance of this paperback original (meaning that there is no hardback edition). In this book, 200,000 words of text and 32 pages of nicely lithographed illustrations are used to tell the story of the construction of all kinds of structures and machines from the earliest times, in Egypt and Mesopotamia, nearly to the present, in Western Europe and the United States.

James K. Finch, Renwick professor emeritus of civil engineering and retired dean of the school of engineering at Columbia University, has for many years pursued as an avocation the study of engineering history; he has published one other book, *Engineering and Western Civilization* (1951), and numerous articles on various aspects of the subject. He is one of a very few engineering teachers who have found interesting and relevant the history of their profession

and who, in the absence of an established academic niche for the subject, have been crying in the wilderness of professional indifference. By way of contrast, the history of science and the history of medicine are recognized and active fields of study.

An enormous amount of material has been crammed into this book, and the thread of narrative is sometimes difficult to keep in sight. However, the very neglect of the field, which the author has been working to set aright, is an important part of the reason for this situation. The detailed monographic studies that are essential if anyone is to write a readable, well-knit, comprehensive history of engineering simply do not exist.

It is to be hoped that many scholars will discover through Finch's writing some of the possibilities of this fertile and exciting field of study, and that a mature and respected discipline of engineering history eventually will rise as a monument to his pioneering work.

EUGENE S. FERGUSON

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Washington, D.C.

Immediate and Low Level Effects of Ionizing Radiations. A. A. Buzzati-Traverso, Ed. Taylor and Francis, London, 1960. xii + 381 pp. Illus. \$8.

This volume, the proceedings of a symposium on the effects of low-level irradiation which was held in Venice in June 1959, is a valuable continuation of the symposium volume on low-level irradiation edited by A. M. Brues and published by the American Association for the Advancement of Science (1959). The Venice presentations give important new information in this steadily growing field; both the papers and the discussions that follow are worthwhile reading. Space does not allow a detailed evaluation of the many aspects covered in the papers, but study of the volume can be highly recommended to those who are interested in the field.

The symposium was held under the joint sponsorship of UNESCO, the Comitato Nazionale per le Ricerche Nucleari of Italy, and the International Atomic Energy Agency.

A. T. KREBS

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Laboratory and University of
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Social Change. H. Ian Hogbin. Watts, London, 1958; Humanities Press, New York, 1960. viii + 257 pp. Illus. \$4.50.

In this expanded version of the Josiah Mason lectures delivered several years ago at the University of Birmingham, Ian Hogbin, an Australian anthropologist, examines a variety of conditions inducing social change. The emphasis is upon historically observed changes now taking place among primitive peoples, with examples drawn from the anthropological literature and from the author's own field work among Pacific Island natives. As a contribution to a general theory of social change, which it makes some claim to being, the book is handicapped by the anecdotal method that chooses random examples rather than systematic and controlled comparisons. In addition, it suffers from the drawbacks of the British functionalist theory, a theory that has been traditionally of a nonhistorical nature.

The real merit of the book lies in its perceptive analysis of many instances of acculturation, each illustrating some important aspect of change. Hogbin's discussion includes such matters as the effects of a money economy upon kinship, native resistance to latrines, the complex linkages of sorcery to social structure, and the pitfalls of administrative meddling in this sensitive area. He notes the unexpected ways in which natives interpret cherished European doctrines. As a striking instance of social chain reaction, he narrates how a single item of western culture, the steel axe, transformed the life of an Australian tribe. The examples document the basic interrelatedness of social institutions, customs, and values. The conclusion is obvious: If change in a society is to be administered with regard for consequences, the society must be understood in its entirety.

Change, the author recognizes, is inevitable and every social order must face the prospect of extinction. With knowledge, better social orders may be planned. From the native point of view, however, our best intentions may seem arbitrary. As one Melanesian told Hogbin, "In olden days we behaved as our fathers did before us. The white man has come and tells us we must behave like his father."

IRVING GOLDMAN

Department of Anthropology,
Sarah Lawrence College

Nutrition animale. vol. 2, *Données générales.* Part 1, *Métabolismes et transits.* H. Le Bars, H. Simmonet, and R. Jacquot. Baillière, Paris, 1960. ii + 490 pp. Illus. NF. 50.

Part 1 of the second volume of this encyclopedic treatise on animal nutrition covers the metabolism of water and nutrients in the animal body. The broad coverage actually constitutes a comparative presentation of our present knowledge of the nutrition of higher animals including man. Herein lies the greatest value of the work and the reward for the serious student who has the patience and persistence to penetrate, under the guidance of the eminent authors, the difficult subject matter.

FRANCIS JOSEPH WEISS

Arlington, Virginia

New Books

Mathematics, Physical Sciences, and Engineering

Air Research and Development Command, Geophysics Research Directorate. Handbook of Geophysics. Macmillan, New York, rev. ed., 1960. 697 pp. \$15. The *Handbook* was first published in 1957 for use by prime contractors of the Air Force; data obtained from satellite and rocket explorations, arctic expeditions, solar observations, and balloon flights were used in this revision.

Boley, Bruno A. and Jerome H. Weiner. *Theory of Thermal Stresses.* Wiley, New York, 1960. 602 pp. \$15.50. Chapters 1-4 cover the fundamentals of thermoelasticity; chapters 5-7 discuss the physical basis of the subject and methods of solving heat conduction boundary-value problems; chapters 8-13 cover practical aspects, mainly form the viewpoint of strength of materials; chapters 14-16 discuss the manner in which temperature effects can be included in inelasticity theory.

Bunshah, Bointan F., Ed. *Transactions of the Vacuum Metallurgy Conference, 1959.* New York Univ. Press, New York, 1960. 222 pp. \$7.50. Contains the papers presented during the conference sponsored by the Department of Metallurgical Engineering in cooperation with the Office of Special Service to Business and Industry of New York University, 1-3 June 1959.

Coy, Paul H. *Structural Analysis of "Unistrut" Space-Frame Roofs.* Part A, *Recommended Methods for Computation of Safe Roof Loads;* Part B, *Tables of Computed Factors to be Used in Safe Load Computations.* Univ. of Michigan Press, Ann Arbor, 1960. 267 pp.; 59 pp. 2 vols., \$18.

Davids, Norman, Ed. *High Speed Testing.* vol. 1. Interscience, New York, 1960. 119 pp. \$10. This symposium (held in December 1958), was the first in a series of symposia devoted entirely to high-speed

testing. The papers were concerned with plastics, solid fuels, cushioning materials, textiles, and metals.

Davidson, Norman, Ed. *International Symposium on Stress Wave Propagation in Materials*. Interscience, New York, 1960. 350 pp. \$5. The symposium, sponsored by the Office of Ordnance Research and the Pennsylvania State University, was attended by over 200 engineers and scientists, representing industrial, university, and government laboratories from ten countries.

Ernst, George C. *Ultimate Moments and Shears in Continuous Reinforced Concrete Beams*. Univ. of Michigan Press, Ann Arbor, 1960. 46 pp. + plates. \$4.

Gatos, Harry C., Ed. *Properties of Elemental and Compound Semiconductors*. Interscience, New York, 1960. 351 pp. \$8.50. Volume 5 in the Metallurgical Society Conferences series.

Henderson, F. M. *Elliptic Functions with Complex Arguments*. Univ. of Michigan Press, Ann Arbor, 1960. 43 pp. + pts. 1-4. \$8.

Levine, Daniel, et al. *Radargrammetry*. McGraw-Hill, New York, 1960. 351 pp. \$12.

Lion, Kurt S. *Instrumentation in Scientific Research*. Electrical input transducers. McGraw-Hill, New York, 1959. 339 pp.

Maxwell, E. A. *Advanced Algebra*. pt. 1. Cambridge Univ. Press, New York, 1960. 323 pp. \$2.75.

Mendelssohn, K., Ed. *Progress in Cryogenics*. vol. 2. Academic Press, New York, 1960. 287 pp. \$11.50. Contents: "The storage and handling of cryogenic liquids" (G. H. Zenger); "The gas refrigerating machine and its position in cryogenic technique" (J. W. L. Kohler); "The separation of deuterium on an industrial scale by low-temperature distillation" (M. P. Malkov, A. G. Zel'dovich, A. B. Fradkov, and I. B. Danilov of the Institute for Physical Problems, Academy of Science of the U.S.S.R.); "Low-temperature bubble chambers" (N. C. Barford); "The 1958 scale of temperatures for the liquid helium-4 region" (H. van Dijk); "Resistance thermometers for low temperatures" (C. R. Barber); "The three level solid state maser" (E. O. Schulz-Du Bois); "Methods of nuclear orientation" (E. Ambler).

Menzel, Donald H., Ed. *The Radio Noise Spectrum*. Harvard Univ. Press, Cambridge, Mass., 1960. 191 pp. \$7.50.

Minkoff, G. J. *Frozen Free Radicals*. Interscience, New York, 1960. 157 pp. \$5.

Olkin, Ingram, et al., Eds. *Contributions to Probability and Statistics*. Essays in honor of Harold Hotelling. Stanford Univ. Press, Stanford, Calif., 1960. 526 pp. \$6.50. The 42 papers by associates of Hotelling include both applied and theoretical material in the fields of statistics, probability theory, economics, and biostatistics. An eight-page bibliography of Hotelling's publications (other than reviews) is included.

Runcorn, S. K., Ed. *Methods and Techniques in Geophysics*. vol. 1. Interscience, New York, 1960. 383 pp. \$10.

Rusk, Rogers D. *Introduction to College Physics*. Appleton-Century-Crofts, New York, ed. 2, 1960. 955 pp. \$8.

Sadler, D. H., Ed. *Transactions of the International Astronomical Union*, vol. 10. Cambridge Univ. Press, New York, 1960. 783 pp. \$17.50. Contains the draft reports of the individual commissions, reports of the meeting, and reports of the four joint discussions held during the 10th general assembly (held in Moscow). It does not contain the proceedings of the symposia held in conjunction with the meeting; they are being published separately.

Schneer, Cecil J. *The Search for Order*. The development of the major ideas in the physical sciences from the earliest times to the present. Harper, New York, 1960. 415 pp. \$6.

Seifert, William W., and Carl W. Steeg, Jr., Eds. *Control Systems Engineering*. McGraw-Hill, New York, 1960. 978 pp. \$15. Intended as a textbook for a graduate-level course in control and as a source of reference material for the control-system engineer.

Sharpe, J. *Nuclear Radiation Measurement*. Simmons-Boardman, New York, 1960. 78 pp. \$2.75.

Shklovsky, I. S. *Cosmic Radio Waves*. Translated by Richard B. Rodman and Carlos M. Varsavsky. Harvard Univ. Press, Cambridge, Mass., 1960. 460 pp. \$12.50.

Smale, A. A., and L. R. Wager, Eds. *Methods in Geochemistry*. Interscience, New York, 1960. 471 pp. \$13.60.

Stacey, M., J. C. Tatlow, and A. G. Sharpe, Eds. *Advances in Fluorine Chemistry*. vol. 1. Academic Press, New York; Butterworths, London, 1960. 210 pp. \$8.

Strobel, Howard S. *Chemical Instrumentation*. A systematic approach to instrumental analysis. Addison-Wesley, Reading, Mass., 1960. 671 pp. \$9.75. Text for advanced undergraduate or graduate work.

Timmerhaus, K. D., Ed. *Advances in Cryogenic Engineering*. vol. 5. Plenum Press, New York, 1960. 592 pp. \$13.50. Proceedings of the 1959 conference held at the University of California (Berkeley) on 2-4 September.

Tipton, C. R., Jr., Ed. *Reactor Handbook*. vol. 1. *Materials*. Interscience, New York, ed. 2, 1960. 1222 pp. \$36.50. This series (four volumes are planned) constitutes a revision of the *Reactor Handbook* published by the Atomic Energy Commission in 1955. The first part of this volume covers topics related to health and safety standards and procedures, radiation damage, D₂O-H₂O separation, and zirconium-hafnium separation; the other parts cover fuel materials, cladding and structural materials, control materials, moderator materials, and shielding materials. The 118 contributors and their professional affiliations are given.

Ubbelohde, A. R., and F. A. Lewis. *Graphite and Its Crystal Compounds*. Oxford Univ. Press, New York, 1960. 230 pp. \$5.60.

Vavra, M. H. *Aero-Thermodynamics and Flow in Turbomachines*. Wiley, New York, 1960. 625 pp. \$14.50.

Wiech, Raymond E., Jr., and Robert F. Strauss. *Fundamentals of Rocket Propulsion*. Reinhold, New York; Chapman and Hall, London, 1960. 151 pp. \$5.50.

Wilson, J. G., and S. A. Wouthuysen, Eds. *Progress in Elementary Particle and*

Cosmic Ray Physics. vol. 5. North-Holland, Amsterdam; Interscience, New York, 1960. \$10.75.

Yatsimirskii, K. B., and V. P. Vasil'ev. *Instability Constants of Complex Compounds*. Translated by D. A. Paterson; R. H. Prince, Translation Editor. Pergamon Press, New York, 1960. 226 pp. 42s.

Reprints

Altman, David, James M. Carter, S. S. Penner, and Martin Summerfield. *Liquid Propellant Rockets*. Princeton Univ. Press, Princeton, N.J., 1960. 196 pp. \$2.95. This volume is the first in the new series "Princeton Aeronautical Paperbacks." The series will make available in small paperback volumes those portions of the larger Princeton Series which it is felt will be most useful to both students and research engineers.

Bellairs, Angus d'A. *Reptiles*. Life history, evolution, and structure. Harper, New York, 1960 (reprint of ed. 1, 1957). 192 pp. \$1.35.

Bragg, Sir William. *The Universe of Light*. Dover, New York, 1960. 306 pp. \$1.85. Unabridged republication of ed. 1. A nontechnical explanation of the phenomenon of light.

Cain, A. J. *Animal Species and Their Evolution*. Harper, New York, 1960 (reprint of ed. 1, 1954). 190 pp. \$1.35.

Davenport, H. *The Higher Arithmetic*. An introduction to the theory of numbers. Harper, New York, 1960 (reprint of ed. 1, 1952). 172 pp. \$1.35.

Findlay, Alexander. *Chemistry in the Service of Man*. Harper, New York, 1960 (reprint of ed. 8, 1957). 336 pp. \$1.75.

Hayes, Wallace D. *Gasdynamic Discontinuities*. Princeton Univ. Press, Princeton, N.J., 1960. 76 pp. \$1.45. Number 3 in the Princeton Aeronautical Paperbacks series.

Huggest, Clayton, C. E. Bartley, and Mark M. Mills. *Solid Propellant Rockets*. Princeton Univ. Press, Princeton, N.J., 1960. 176 pp. \$2.45. Number 2 in the Princeton Aeronautical Paperbacks series.

Jones, Robert T., and Doris Cohen. *High Speed Wing Theory*. Princeton Univ. Press, Princeton, N.J., 1960. 248 pp. \$2.95. Number 6 in the Princeton Aeronautical Paperbacks series.

Lighthill, M. J. *Higher Approximations in Aerodynamic Theory*. Princeton Univ. Press, Princeton, N.J. 1960. 156 pp. \$1.95. Number 5 in the Princeton Aeronautical Paperbacks series.

Littlewood, D. E. *The Skeleton Key of Mathematics*. A simple account of complex algebraic theories. Harper, New York, 1960 (reprint of ed. 1, 1949). 138 pp. \$1.25.

Partington, J. R. A. *Short History of Chemistry*. Harper, New York, 1960 (reprint of ed. 3, 1957). 429 pp. \$1.95.

Read, John. *A Direct Entry to Organic Chemistry*. Harper, New York, 1960 (reprint of 1959 edition). 282 pp. \$1.50.

Sears, W. R. *Small Perturbation Theory*. Princeton Univ. Press, Princeton, N.J., 1960. 72 pp. \$1.45. Number 4 in the Princeton Aeronautical Paperbacks series.

Reports

Science Teachers and the Scientific Attitude: An Appraisal of an Academic Year Institute

Abstract. In a training program for experienced high school science and mathematics teachers, trainees made good academic progress and eventually adjusted well to the return to university work. The program's main weakness was failure to transmit attitudes and information relevant to teaching science, not only as a body of knowledge, but as a way of thinking.

Since its inception in 1950, the National Science Foundation has sponsored a many-sided and far-reaching effort to improve science education. One of its most important programs in this field is the Academic Year Institute. High school teachers of science and mathematics are given stipends to permit them to return to the university for a year of advanced training adapted to their special needs. The courses of study are intended to deal with the subject matter of science and mathematics, not with teaching methods.

The number of institutes has grown from two in 1956-57 to 32 in 1959-60, with about 50 fellows in each, and about 3000 teachers have already been involved in the program. The potential impact of a program of this magnitude on the quality of high school teaching is very great, but unless the additional work is qualitatively different from the 15 or 16 years of education which preceded it, one should not expect an important change in the individual fellow. This suggests the importance of examining the methods and effects of the program, and although this has not been done on a national basis, several participating institutes have

chosen to have their work systematically scrutinized. The Academic Year Institute faculty at the University of Colorado were among those who not only endured but welcomed and made use of scrutiny and criticism. Evaluation of the Colorado program was conducted by the Behavior Research Laboratory at the university.

Fifty-five high school science and mathematics teachers came from all parts of the country to Boulder to study at the institute held in 1957-58. As can be seen from the data in Table 1, the fellows were a group of mature, intelligent, and experienced teachers. Their previous training in science and mathematics had been mediocre but not unusually poor; it was above some standards and below others.

In many important respects the initial year of the program was a success. The fellows made good academic progress and were, by the end of the year, quite satisfied with the program. Their average grade in all courses was B—an acceptable average for graduate credit at the University of Colorado—and they gave the program an average rating on a 7-point scale of 5.5, which corresponds to "very good." A new degree, Master of Basic Science, was proposed by the Academic Year Institute faculty and accepted by the Graduate School. Requirements for this degree stress breadth of training rather than the specialization characteristic of other graduate programs. Of the 53 fellows who completed the year, 28 received the M.B.S. degree in 1958 and others have gone on to earn the degree since then.

The program faced three major difficulties: (i) disorientation and a serious drop in morale among the fellows, due largely to the sudden change from the status of teacher to that of student; (ii) conflict because the fellows desired to improve their knowledge of teaching techniques as well as subject matter while the faculty was concerned almost entirely with subject matter; (iii) conflict between the need to cover specific subject matter and the more general goal of improving the fellows' broad grasp of the character of science. In the main, the first two problems were solved, partly by clarify-

ing objectives and standards and partly by making some concessions to the special needs of the fellows. The third problem remained as the major weakness of the program; little if any progress was made in the development of a general understanding of the nature of scientific thinking.

Evidence of this weakness was provided by a test of knowledge of the history of science, a questionnaire on the philosophy of science, and a sample teaching performance. In the history of science test, 92 percent of the fellows performed below a standard suggested as adequate by four Academic Year Institute faculty members.

Two types of questions were used in this examination. First, the fellows were asked to arrange sets of three names in chronological order, the names in each set being chosen so that knowledge of the scientific contributions of the men would make solution possible without knowledge of the specific years in which they lived (for example: Copernicus, Galileo, Newton). Secondly, they were asked to match the names of scientists with their major contributions to knowledge—for example, Harvey and the circulation of the blood.

Of the 52 fellows taking this test (see Table 2), only 28 put Faraday first in chronological order in question 1; only 25 put Copernicus first in question 2. In question 6, only 19 knew that Darwin came last, and 11 put Darwin before both Linnaeus and Lamarck.

Another approach to the problem of examining the fellows' grasp of the general character of science was a questionnaire, administered at the beginning and end of the year, dealing with their views on the philosophy of science. There is obviously no "right answer" in this area, but one can at least look for signs of growth of appreciation and grasp of problems in the area. The results suggest that no such growth occurred. For example, little consistency in initial views and little change of views could be detected. In one question, the fellows were asked to decide whether each member of a list of terms was a "concept invented by

Table 1. Description of fellows.

Item	N*	Median	Range
Age	54	32	25-48
Army General Classification Test	51	140	118-155
Semester hours in science and mathematics	54	55	19-106
Semester hours in education	54	27	5-69
Years teaching	54	7	3-15

* Although 55 fellows began the program, one dropped out very early, and a few others missed some of the tests.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should not repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to one 2-column figure (that is, a figure whose width equals two columns of text) or to one 2-column table or to two 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

Table 2. Data on correct and incorrect answers in history of science test: eight sets of names to be arranged in chronological order.

Names	Number		
	Correct	Incorrect	Blank
1. Faraday, Hertz, Maxwell	10	30	12
2. Copernicus, Galileo, Newton	23	23	6
3. Berzelius, Kekule, Pasteur	12	26	14
4. Weierstrass, Cantor, Dedekind	3	24	25
5. Mendeleef, Dalton, Lavoisier	12	30	10
6. Darwin, Lamarck, Linnaeus	13	30	9
7. Leibniz, Descartes, Gauss	16	20	16
8. Leeuwenhoek, Schwann, Koch	19	21	12

man" or "a physical reality independent of the observer"; the terms used were *trees, mountains, stars, genes, gravity, photons, molecules, and species*. There was virtually no change in response to most of the items in this question or in the number of items designated as "concepts" by the fellows (pretest median = posttest median = 2). Two interesting shifts in opinion took place: in the posttest, seven more fellows saw *genes* as concepts than in the pretest, and seven more saw *photons* as physical realities. Was a move toward "naive realism" in the way they looked at the photon coupled with a move toward "logical positivism" in the way they looked at the gene?

In a related question, the fellows definitely shifted away from the view that mathematical axioms are "self-evident truths" and toward the view that such axioms are "arbitrary conventions."

These results suggest that one can fairly easily inculcate specific changes in thought that have little general effect on the individual's approach to science as a whole. Philosophical issues were not discussed enough in the program to permit much clarification; the changes that did occur resulted from the specific ways in which different faculty members handled certain topics in their classes. One of the fellows, in fact, commented on "knowing the right answer" from attending the seminar in mathematics. The larger issue—of developing some mature appreciation of the history and philosophy of science—has yet to be dealt with; meanwhile, it is perhaps encouraging that some changes in this domain of thought can be made.

Evidence that the fellows had not learned to teach students much about the way in which scientific progress is achieved was given by their sample teaching performances. Each of a representative group of fellows gave a

half-hour talk on a topic of his own choice designed for a high school classroom. In these short talks the fellows were almost entirely preoccupied with presenting the known facts and principles of science and mathematics. Very seldom was any effort made to convey a sense of the way in which scientific thought unfolds—the thinking and research lying behind the material the teacher was presenting. The history leading up to a scientific discovery and the consequences of such a discovery were never discussed. Within these limitations many of the talks were fluent, interesting, and well organized. There was no change in performance from the beginning of the year to the end of it, except that on occasion the later talks drew on specific material learned in the Academic Year Institute.

It may be that the institute's preoccupation with the goal of teaching specific science material prevented it from dealing adequately with other goals envisioned for the program—envisioned, at least, by the faculty concerned. The working assumption of the institute in its initial year was that if subject matter is adequately taught, other things will take care of themselves. The main conclusion of the evaluation group is that such an assumption is at best questionable.

Science plays an increasingly large part in every individual's life; if it reaches him only through its technological fruits, man will be increasingly divorced from nature, and scientific progress will, paradoxically, impoverish his intellectual and cultural life; but if the study of science gives man a deeper appreciation of nature and increased ability to enjoy the pleasures of rational thought, it will ennoble and enrich him. To accomplish these ends, science teachers must do more than study what scientists know; they must understand how scientists think.

HOWARD E. GRUBER

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Notes

This study was supported by the Academic Year Institute at the University of Colorado, with funds from the National Science Foundation. For a more detailed report of the methods and results of the evaluation, see H. E. Gruber, K. P. Brady, and J. R. Means, "Toward the Improvement of Science Teaching," *University of Colorado Behavior Research Lab. Rep. No. 9*. The findings reported here led the evaluation group, in cooperation with the Academic Year Institute faculty, to develop and test experimentally a method of overcoming the difficulties described.

For related discussion, see P. F. Brandwein, F. G. Watson, P. E. Blackwood, *Teaching High School Science: A Book of Methods* (Harcourt, Brace, New York, 1958); J. B. Conant, *On Understanding Science* (Yale Univ. Press, New Haven, 1947); J. R. Oppenheimer, *Physics in the Contemporary World* (Anthoensen, Portland, Me., 1947).

20 April 1960

Biosynthesis of Chick Hemoglobins

Abstract. In vivo studies of the biosynthesis of chick hemoglobins 1 and 2 showed an over-all higher incorporation of glycine-2-C¹⁴, valine-4-C¹⁴, valine-1-C¹⁴, leucine-G-C¹⁴, and histidine-(2-ring)-C¹⁴ in hemoglobin 2; in vitro studies made with intact nucleated chick erythrocytes showed the higher incorporation of glycine-2-C¹⁴, valine-1-C¹⁴, and histidine-(2-ring)-C¹⁴ in hemoglobin 1. Hybridization of chick hemoglobins produced an electrophoretically distinguishable new component.

Paper electrophoretic investigation on the cell-free hemolyzates obtained from the erythrocytes of birds like chick, guinea fowl, and duck revealed the presence of two hemoglobins (1). It has further been observed that in chick one of these hemoglobins (Hb 1) decreases while the other (Hb 2) increases during development (2). Both of these hemoglobin components were found to be of the alkali-resistant type (3). In view of these findings, it was of interest to investigate the biosynthesis of individual hemoglobin components of chick. This report presents the results of the investigation carried out with adult chicks injected with radioactive amino acids, and the in vitro incorporation of C¹⁴-labelled amino acids in the hemoglobin components by the nucleated chick erythrocytes.

For in vivo studies, 6-month-old male white leghorn chicks were intravenously injected with 25 μ C of amino acid-C¹⁴. Thereafter, 4 ml of heparinized blood was collected from each chick on alternate days for 2 weeks and then every 4th day until the 28th day after the injection. Blood samples were washed four times with ten times their volume of isotonic saline at 2°C in a refrigerated centrifuge. Clear hemoglobin solutions were obtained by hemolysis with water and toluene and by centrifugation as described earlier (1).

For in vitro studies, chicks were made mildly anemic with injections of acetylphenylhydrazine. Acetylphenylhydrazine (25 mg) was injected subcutaneously three times, once every 4th day, followed by an initial withdrawal of 15 ml of blood. After this, approximately 10 ml of blood was withdrawn and 20 mg of acetylphenylhydrazine was injected every week. Heparinized blood samples were obtained from these birds 48 hours after the injection of acetylphenylhydrazine. During the washing procedure, care was taken not to remove the light colored upper layer which contained reticulocytes. In the in vitro experiments, to one volume of erythrocytes equal volumes of normal chicken plasma and a synthetic media containing an amino acid mixture as described by Borsook (4) (glucose, 1.0 mg/ml; Na-penicillin G and strepto-

mycin sulfate, each, 0.1 mg/ml; FeSO₄, (NH₄)₂SO₄·6H₂O, 5 μg/ml; MgCl₂, 2.85 mg/ml; α-ketoglutaric acid, 10 mg/ml; pyridoxal-5-phosphate, 17 μg/ml; and 5 to 10 μC of glycine-2-C¹⁴, leucine-G-C¹⁴, valine-1-C¹⁴, valine-4-C¹⁴ and histidine-(2-ring)-C¹⁴ were added. Incubation was carried out at 37°C for 4 hours, in air. After incubation, the mixtures containing chick erythrocytes were washed six times with ten times their volume of isotonic saline, and hemoglobins were extracted as described previously.

Paper electrophoresis was conducted in barbiturate buffer (pH, 8.6; μ, 0.05) for 16 to 18 hours with 220 volts at 4°C in a horizontal paper electrophoresis apparatus. After the paper electrophoretic run was over the peak areas were cut out and eluted with water in a water-saturated, all-glass, chromatographic chamber. Since the concentration of hemoglobin 1 is always higher than that of hemoglobin 2, the eluted solutions containing hemoglobin 1 were diluted approximately to the concentration of hemoglobin 2 fractions in order to minimize errors in measurement of hemoglobin content and of specific radioactivity. The hemoglobin content of the fractions was determined as carbomonoxyhemoglobin at 540 mμ in a Beckman DU spectrophotometer, and radioactivity was determined with a windowless gas-flow counter. The results were calculated as the specific activity, counts per minute per milligram of hemoglobin, divided by the number of micromoles of a particular amino acid present per milligram of the hemoglobin component. The amino acid content used in calculation was based on the results reported by Helm and Huisman (5).

Table 1 presents the ratio of the specific activity of the chick hemoglobins 1 and 2 corrected for the differential amount of amino acids present in each component during the period of in vivo studies. It may be observed that throughout the period of investigation, except for the 2nd- and

Table 1. In vivo biosynthesis of chick hemoglobins 1 and 2. Values are ratios of the rate of amino acid-C¹⁴ incorporation in hemoglobin 2 to the rate in hemoglobin 1. Rates were calculated from specific activity per mg of hemoglobin corrected to 1.0 micromole of the particular amino acid present in each hemoglobin component.

Days after injection	Glycine -2-C ¹⁴	Leucine -G-C ¹⁴	Histidine-(2-ring)-C ¹⁴	Valine -1-C ¹⁴	Valine -4-C ¹⁴
2	0.86	*	*	1.35	1.00
4	1.01	0.75	1.00	1.37	1.00
6	1.38	1.53	2.25	1.74	2.59
8	1.26	2.08	1.76	0.95	1.06
10	1.77	1.50	1.82	1.08	1.11
12	1.48	1.47	1.74	1.07	1.10
14	1.85	1.30	1.20	0.97	1.18
16	1.44	1.04	2.16	0.99	1.17
20	1.53	1.13	1.13	0.82	1.19
24	1.36	1.06	1.57	0.91	1.10
28	1.99	1.33	1.07	0.73	1.24
32	1.39				
36	1.58				
Over-all ratio	1.45	1.31	1.62	1.08	1.23

* Specific activities were too low to be recorded.

4th-day results, hemoglobin 2 shows an over-all higher specific activity than hemoglobin 1. The results are in agreement with the earlier observation that during development chick hemoglobin 2 increases from 29 percent to 39 percent, while hemoglobin 1 decreases from 73 percent to 61 percent (2). However, the observed higher amino acid-C¹⁴ incorporation in component 1 in the first days of analyses could not be explained as a result of preferential production of one hemoglobin component by the living system during development. It may, however, be pointed out that paper electrophoretic analyses undertaken on a large number of chicks representing the different age groups starting from the embryonic chicks to adult ones always revealed the presence of both the hemoglobins. Similar in vivo experiments with leucine-G-C¹⁴ were performed on guinea fowl, and the results obtained resemble those reported with chicks.

Table 2 shows that, unlike the in vivo system, the chick erythrocytes incorporate amino acid-C¹⁴ more in component 1. The rate of incorporation was found to be higher in the anemic birds but the ratio of incorporation in hemoglobin 1 to that in hemoglobin 2 does not show any remarkable change from the ratio obtained with the normal birds. Thus it appears that the erythrocytic production of hemoglobins brings about higher incorporation of radioactive amino acid in hemoglobin 1 during the first days of in vivo studies. It seems that while the nucleated chick erythrocytes synthesize greater amounts of hemoglobin 1, the hemopoietic system as a whole reverses the ratio of the erythrocytic production of hemoglobins 1 and 2. According to the template theory of protein synthesis polypeptide chains are synthesized in microsomal nucleoprotein templates containing ribonucleic acid, which in turn are organized by chromosomal deoxyribonucleo-

proteins. The present investigation reveals that both the genes which control the molecular conformations of hemoglobins 1 and 2 are present in the chick erythrocytes and so also are the rate-determining factors controlling the production of these hemoglobins. Differences in the composition or in the state of internal milieu probably determine to a large extent the relative rates of hemoglobin synthesis.

Hybridization of chick hemoglobins 1 and 2 was carried out with a method similar to that outlined by Itano and Singer (6). A new component with a mobility intermediate between the positions of hemoglobins 1 and 2 appears (Fig. 1). Similar results were obtained with pigeon and duck hemoglobins. This observation provides evidence of the dissociation of chick hemoglobins 1 and 2 into two unlike subunits in each case. Oxygen equilibria studies of chick hemoglobins dissolved in urea (4.0M) and sodium chloride (4.0M) also indicated the dissociation into half

Table 2. In vitro biosynthesis of chick hemoglobins 1 and 2. Values represent rates of incorporation. A 3 ml volume of packed erythrocytes was suspended in 6 ml of medium containing equal amounts of normal chicken plasma and synthetic medium. Incubation was carried out in 50 ml erlenmeyer flasks in Warburg apparatus which was modified to produce a rotary shaking of 100 cycles per minute.

Normal chick			Anemic chick		
Hb 1	Hb 2	Hb 1/Hb 2	Hb 1	Hb 2	Hb 1/Hb 2
Valine-1-C ¹⁴					
16.6	8.0	2.0	47.8	21.6	2.2
Histidine-(2-ring)-C ¹⁴					
27.0	8.0	3.3	45.0	20.0	2.5
Glycine-2-C ¹⁴					
19.7	13.2	1.5	100.4	35.4	2.8
13.1	4.3	3.0	245.7	168.0	1.4
49.1	42.1	1.2*	192.6	130.3	1.5*
94.5	64.3	1.5†			

* Experiments were conducted with 2-week-old chicks. † Erythrocytes were incubated in plasma alone.



Fig. 1. Ascending boundary patterns of free electrophoresis of chick carbonmonoxyhemoglobins 1 and 2 in Na-phosphate buffer, pH 6.8; μ 0.02. (A) control; (B) test; hemoglobins 1 and 2 were dissociated in Na-acetate buffer, pH 4.7; μ, 0.2 for 5 hours at 3°C and returned to Na-phosphate buffer, pH 6.8; μ, 0.02.

molecules (7). Presumably there are units in these molecules which may be represented by $\alpha_1 \alpha_2$ and $\beta_1 \beta_2$ in chick hemoglobin 1, and $\alpha_1 \alpha_2$ and $\beta_1 \beta_2$ in chick hemoglobin 2. Since only three components are detected electrophoretically, it seems that either $\alpha_1 \alpha_2$ - and $\alpha_2 \alpha_2$ -, or $\beta_1 \beta_2$ - and $\beta_2 \beta_2$ -units of polypeptide chains are identical. One may wonder, however, whether these dissociations and recombinations are possible in the animal system. Results obtained on the *in vitro* and *in vivo* biosyntheses of chick hemoglobins suggest the possibility of the transfer of one of the subunits from one of the hemoglobins to the other. On the other hand, the rate of production of these three subunits may be genetically so controlled that they lead to results like those demonstrated here. However, mutations in any one of these genes would give rise to numerous hemoglobins in the avian species which have been experimentally observed earlier (1, 8, 9).

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Simultaneous Study of Behavior and Brain Waves

Abstract. A technique for the simultaneous audiovisual recording of behavior and brain waves is described. The absence of muscle movement artifact, despite unlimited activity of the patient, suggests that telemetering may be adaptable for routine electroencephalography.

This preliminary report describes our development of an audiovisual technique for the simultaneous study of a patient's behavior and electroencephalogram (EEG).

In the Children's Service of the Langley Porter Neuropsychiatric Institute,

where research is primarily concerned with defining the etiologic role of experiential factors in childhood schizophrenia (1), the possible contribution of any organic factor in all children seen is studied with all the facilities and skills available, since the differentiation between schizophrenic children and emotionally disturbed children with mental deficiency or organic brain disease may be initially difficult. We occasionally find EEG dysrhythmias in children of varied diagnoses without any historical or clinical evidence of a convulsive disorder. For such cases we were particularly interested in devising a technique for the more precise study of the correlation, if any, between behavior and dysrhythmias.

In 1951 Berlin and Yeager (2) noted that the level of emotional tension in epileptic children may be correlated with the frequency and severity of seizures as well as the degree of EEG dysrhythmia and, in 1956, Yeager and Guerrant (3) reported that a patient's performance, as measured by finger tapping, was altered sometimes during a paroxysmal burst on the electroencephalogram without any other apparent clinical evidence suggesting seizure activity.

In 1958 (4), a transistorized telemeter about the size of a "king-size" package of cigarettes was developed by the Research and Development Laboratory of the University of California Medical Center, San Francisco. The telemeter shown in operation on a child in Fig. 1 uses a circuit, previously described in detail (4), which consists of a four-stage transistor amplifier, a reactance modulator, and a 30-Mcy/sec oscillator which produces signals frequency-modulated by the patient's scalp voltages. The brain waves may be telemetered to an antenna within a radius of 40 feet and then coupled by a frequency-modulated receiver to a conventional electroencephalograph. Either needle or disk scalp electrodes may be used. Thus a trace can be made while the child, unencumbered by leads, is able to move about freely.

Preliminary trials with the telemeter produced traces with a surprising absence of muscle movement artifact (Fig. 1 includes such a trace). We then considered how a 16 mm motion picture camera might be utilized to photograph the child and the telemetered electroencephalogram on the same film.

With a motor-driven 16 mm camera with masks behind the lens which allowed exposure of either two-thirds or one-third of each film frame, we photographed the child, notching the film at a landmark in the camera before starting the motor. The instant the camera motor was started the EEG trace was marked. The upper third of

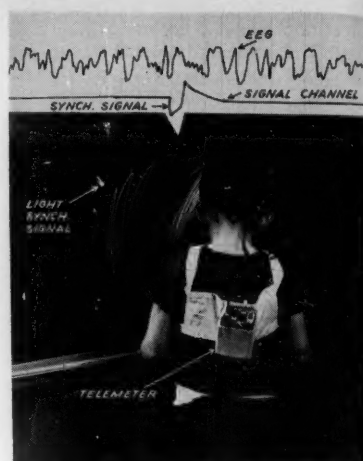


Fig. 1. Effect achieved in a frame of the motion picture film. The composite photograph was prepared because of technical difficulties involved in enlarging directly from the film.

the film was masked for this first exposure.

After 100 feet of film were exposed without interruption, the film was rewound in a darkroom, replaced in the camera, and the notch in the film was aligned with the same landmark as before. The EEG trace was also rewound to the mark made when the camera motor was started, and the lens mask was changed to expose the remaining third of each film frame. The camera and EEG motors were then started simultaneously.

Although our first film was satisfactory photographically, we had no demonstrable proof that synchronization of the child's behavior and the electroencephalogram was either initially correct or was maintained.

We then decided to use a sound camera and a system to check synchronization.

Using this system, we modulated the electroencephalogram into an audible frequency directly recorded on the sound track at the first filming. We also devised a signal system in which pressing a button flashed a light on the wall of the playroom, produced an audible click in the modulated electroencephalogram, and marked the EEG trace on a second channel. This signal was triggered by one of us each time a paroxysmal burst occurred on the electroencephalogram (a frequent occurrence with the patient studied, who manifested a hypsarhythmic record).

Our technique of marking the film and the electroencephalogram, masking the film and rewinding it and the EEG trace after the initial exposure, and

then rephotographing the trace was otherwise unchanged.

Synchronization was insured on the projected film if the light flashed when a portion of film exposed at the first run coincided with the mark on the EEG trace exposed after the film was rewound and the mask changed. Figure 1 illustrates the appearance of the movie during a synchronization check. By this technique, synchronization was maintained throughout 1200 feet of film.

A telemetering system may be adaptable for routine electroencephalography because of the absence of muscle movement artifact despite the patient's unrestricted activity. We are currently developing a miniaturization of the telemeter and increasing the channels to achieve such a system.

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20 May 1960

Relating a Component of Physiological Nystagmus to Visual Display

Abstract. A transactional position suggests the hypothesis that there should be changes in the fine eye movements of a fixating subject if the fixated visual display is altered. It is shown that the mean saccadic eye movements are unequivocally different with different positions of the stimulus within the visual field.

This report resulted from interest in the transactional concepts of perception elaborated by Mead (1) and Dewey (2) wherein an alteration of the receptor by a motor or centrifugal component of the perceptual act is an implicit necessity. These concepts are the equivalent of saying that at any given instant in the perceptual act the perceptual system has used the data taken in so as to be able to change the state of the receptor suitably for taking in the next increment of data. This implies that if the stimulus changes then the cumulative centrifugal actions taken would change. Livingston (3) has recently presented the evidence for centrifugal control mechanisms in the optic nerve, the auditory nerve, the

olfactory bulb, and the stretch receptors, but no attempt has yet been made to study the involuntary fine eye movements of fixation (physiological nystagmus) with transactionally derived hypotheses.

If the fine eye movements were part of a centrifugal control process it should follow that they would not occur at random but would be determined in some manner related to the visual stimulus. The operational hypothesis derived was that if the position of the stimulus within the visual display were changed then the saccadic component of the fine eye movements would change.

The fixation eye movements (physiological nystagmus) of a subject (myself) were measured photoelectrically from light reflected by a small mirror mounted on a tight-fitting scleral contact lens worn by the subject while his head was immobilized on a bite board. The apparatus (4) and its use were similar to that described by Nachmias (5) but differed in that the change in amount of light incident on a photoelectric tube was recorded on a polygraph instead of the movement of a light beam being recorded photographically. The apparatus was sensitive to less than a minute of arc of eye movement. Both the horizontal and vertical components of the eye movements were recorded, and, since the mirror mounted on the contact lens was normal to the visual axis, the torsional eye movements and most head movements were canceled out. Separate runs were made under the four different conditions of having the visual stimulus (Fig. 1) in each of the four visual quadrants, designated clockwise as shown, while the other three quadrants were empty. The display was projected from a slide projector on a white background to cover 14 degrees of visual angle horizontally and vertically, 48 inches from the subject's eye. The runs lasted 45 seconds each and contained an average of 39 saccades (flicks, or small rapid eye movements of a range of 1 to 30 minutes of arc magnitude). There were 20 runs, 5 for each quadrant.

Each saccade was measured horizontally and vertically and a mean saccade was calculated for each run by adding all of the saccadic vectors algebraically and dividing by the number of saccades. Figure 2 shows the distribution of the mean saccades under the four conditions. As can be seen, there is a striking separation of the four groups with only one area of overlap, that between the mean saccades of quadrants 1 and 2. If the grand mean of all mean saccades is taken arbitrarily as a zero point, it can also be seen that there is a tendency for

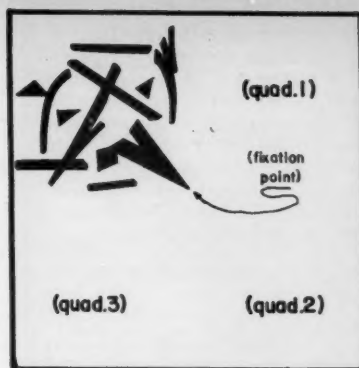


Fig. 1. The visual display. The stimulus is in quadrant 4 in this diagram. The fixation point is always at the center of the field.

the mean saccades to be in a quadrant diametrically opposite to that of the stimulus.

Cornsweet (6) has postulated that the function of saccades is to recenter the eye after a random drift which results from the instability of the oculomotor system. Nachmias (5) has felt his work consistent with Cornsweet's hypothesis. It now seems justified to go considerably further and suspect that saccades are part of a central ocular control mechanism which functions in a determined manner related to the nature of the stimulus. When this hypothesis is combined with the observations of Ditchburn *et al.* (7) and Riggs *et al.* (8), which show that perception is affected by eye movements,

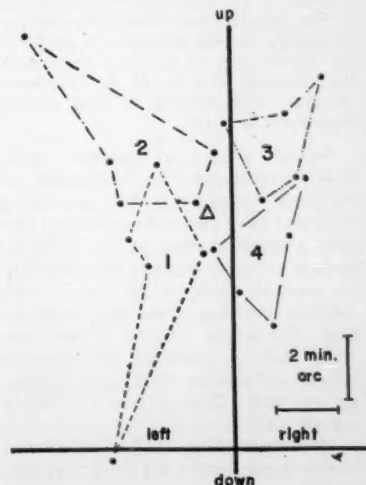


Fig. 2. Distribution of the mean saccades of the four positions. Dotted lines connect the five mean saccades of the same quadrant. Quadrant indicated by number, grand mean of means by Δ .

a new possibility arises, namely, that the fine eye movements are an experimentally predictable derivative of both the stimulus and the percept. This is not to say that other explanations are not possible (9).

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Transfer of Maternal Calcium to the Offspring via the Milk

Abstract. By measuring the specific activities of milk and of maternal and filial long bones 3 months after calcium-45 had been given to the then nonpregnant mothers, it was found that the magnitude of the contribution of the maternal calcium stores to milk formation is similar to the contribution to the bone calcium of the offspring, that is, 10 to 15 percent of either milk calcium or filial calcium is maternal in origin.

Several groups of authors (1-3) have investigated the movement of maternal calcium to the developing fetus and have generally concluded that only a small portion of the maternal skeletal calcium stores is transferred to the embryo, most of the latter's bone calcium deriving from the maternal diet. The actual fraction of fetal calcium that is maternal in origin is imprecisely known, the figures reported varying from 28.6 percent (1) to 12 percent (3).

Hevesy, studying the conservation of maternal calcium in the offspring, concluded from data on calcium content and turnover in mice and their offspring that "The Ca⁴⁵ taken in by the mother has thus only an opportunity of interchanging in the average with about 1/5

Table 1. Comparison of specific activities of milk and of maternal and filial long bones. Percent dose Ca⁴⁵/gm Ca. (Dose given to mother 3 months earlier.)

Litter age (Days)	Mother		Milk	Litter		
	Ends	Shafts		Total	Ends	Shafts
1	13.6	20.0	1.75	2.57 0.99 0.96 1.29 Av. 1.45		
1	48.0	62.5	7.59	8.63 7.96 4.25 6.74 Av. 6.90		
10	43.2	50.0	4.61		7.00 6.80 5.66 1.94*	4.97 5.44 5.23 4.97
					Avs. 6.49	5.15
16	21.6	29.4	3.12		4.67 4.50 6.45 6.28 Avs. 5.48	4.84 4.70 5.63 5.33 5.13

* This figure was not included in calculating the average.

to 1/6 of the body calcium before being utilized in the building up of the embryo" (4, p. 15). This estimate thus agrees with the estimates cited.

The implication of these findings is that when the demand for calcium is high, as in pregnancy, the body can divert most of the incoming calcium atoms from the skeleton, their normal target organ, to the rapidly calcifying fetus (5). It seemed of interest to determine to what extent the pool of maternal calcium participates in milk formation and to estimate whether the endogenous calcium contributed by the mother to the milk calcium derives from the same source as the calcium supplied to the fetus.

To this end, 1-month-old female rats were given Ca⁴⁵ (6) by intraperitoneal injection and caged together with males of the same age. Six to eight weeks later, when the females were found to be pregnant, they were separated and allowed to deliver and then to suckle their young. At predetermined times, the mothers and their litters were killed (ether anesthesia), their right humeri were dissected out, and, in the case of the mothers and older offspring, the proximal ends were separated from the shafts and analyzed for Ca and Ca⁴⁵ (7). In the case of newborn rats, the entire humerus was analyzed; in the older suckling rats, all of the shaft, but in the mothers only a portion of the shaft (proximal metaphysis and part of diaphysis), was analyzed. In addition, the stomach of the offspring was excised, cut open, and the curdled milk was squeezed out and analyzed for Ca and Ca⁴⁵.

Table 1 shows the results of the

analyses. It can be seen that the specific activities of the shafts of the mothers are higher than those of the ends; this indicates that much of the isotope, originally deposited at the epiphyseal plates, is now in the shafts, in accordance with the pattern of growth of long bones worked out by Leblond *et al.* (8). The specific activities of the bones of the offspring were appreciably lower than those of the maternal bones, approximately 1/8 of the specific activity of the ends and 1/10 of the specific activity of the shafts of the maternal bones. These figures are qualitatively similar to, though perhaps lower than, the corresponding figures reported by others (1, 3, 4).

The specific activity of the milk recovered from the offspring is similar to that of their bones. This suggests that the magnitude of the contribution of maternal skeletal calcium stores to milk formation is similar to the magnitude of contribution toward fetal bone formation. In other words, about 10 to 15 percent of the calcium in milk or the filial skeleton is maternal in origin. This estimate represents a minimum figure, however, as some non-labeled dietary calcium may enter the maternal skeleton and then be transferred to the fetus or the milk (3). Furthermore, the maternal bones were not labeled uniformly by the single injection of tracer (7). Consequently, some unlabeled maternal calcium may also have been transferred to the milk or the offspring.

A comparison of the fraction of the dose of Ca⁴⁵ appearing in the milk (0.06 to 0.34, depending apparently on the relation of milk calcium secreted

to the total dietary and body calcium pool available for milk production (9)], with the fraction of maternal calcium recovered in the offspring (1-3) confirms the conclusion drawn here, but this is the first report in which both parameters have been measured (10).

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Culture of a Colonial Hydroid under Controlled Conditions

Abstract. A simple method has been developed for the cultivation of colonies of *Cordylophora lacustris*. The colonies, attached to microscope slides slanted in beakers, are grown in a culture solution containing five required ions. *Artemia* larvae are supplied as food. Increase in hydranth number is exponential with a doubling time of about 3 days.

Among the aquatic invertebrate metazoa, the colonial hydroids are particularly rich in unexploited potentialities for the study of growth and development at the tissue level. The exploitation of these potentialities cannot begin, however, until the organisms can be cultivated under controlled laboratory conditions. The accomplishments of Crowell, Hauenschild, and Kinne are important in this regard, for they have succeeded in growing three colonial hydroids in the laboratory [*Campanularia*, *Hydractinia*, and *Cordylophora*,

see (1)]. Their methods, however, are rather elaborate and uncontrolled, involve the use of ocean water, and lack sufficient versatility to permit extensive variation of conditions. The present report describes a simple method for the controlled cultivation of a colonial hydroid, similar to the method for hydra developed so successfully by Loomis (2).

The organism is a brackish-water hydroid, *Cordylophora lacustris* Allman (3), which is unusually hardy, has great regenerative capacity, and forms a colony which is simpler in structure than that of many of the marine hydroids. Colonies of this sessile organism are grown attached to 1 by 3 inch microscope slides slanted in 100-ml beakers of culture solution (Fig. 1). Such cultures may be grown to a considerable density, whereas cultures grown in the bottoms of dishes quickly become necrotic. Many separate beaker-slide cultures may be maintained and observed with a minimum of effort.

A defined aqueous solution replaces brackish water. *Cordylophora* culture solution (CCS) contains 0.05M NaCl, 0.001M KHCO₃, 0.005M CaCl₂, and 0.005M MgCl₂, and is made up in demineralized water (4). The sodium, potassium, calcium, and chloride ions are absolute requirements for growth, while in the absence of magnesium ions growth continues, but at a reduced rate. Bicarbonate ions are not required, but serve to buffer the solution. The proportions given are approximately optimal for growth. In contrast, *Hydra littoralis* requires only calcium (2) and traces of sodium (5) for optimal growth.

Hydroids are carnivores, and must be fed a completely undefined nutrient: living prey. The use of larvae of the brine shrimp, *Artemia*, for this purpose (1, 2) represents a giant step in the direction of controlled conditions, since *Artemia* larvae provide an unlimited supply of easily raised and highly uniform food. The dried eggs are hatched on a daily schedule (6), and each day the larvae are collected and washed, and the *Cordylophora* colonies are fed to repletion for about an hour. The culture solution is changed after feeding and again several hours later (7). Colonies are maintained at 22°C.

Asexual *Cordylophora* colonies are composed of three repeating units: hydranths, stems, and stolons. Tubular stolons grow out attached to the substratum, and perpendicular to the stolons uprights rise at regular intervals, each upright bearing a hydranth at its apex. The stems of the uprights lengthen and at intervals develop side branches which bear additional hydranths. Branches develop secondary and tertiary branches, and stolons also branch. While such a colony gives the general impression of a rambling bush, the pattern is highly regular and results

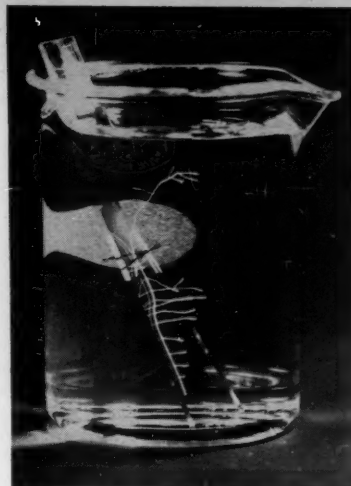


Fig. 1. A young *Cordylophora* colony growing on a slide in a 100 ml beaker of CCS. The portion above the thread is unattached. There are 19 hydranths.

from the relative rates of growth and spacing of the repeating units.

Secondary asexual colonies are started by removing single uprights from a well-developed colony and tying them to microscope slides with thread (8). A new stolon develops at the cut base of the upright, attaches to the slide, and begins the developmental sequence described above. Simultaneously, the original upright continues to elongate (without attaching to the slide) and branches (Fig. 1). Secondary colonies are allowed to develop for about a week and then are ready for use in experiments.

A measure is needed of what, in a general sense, constitutes increase with time in a growing colony. One unit

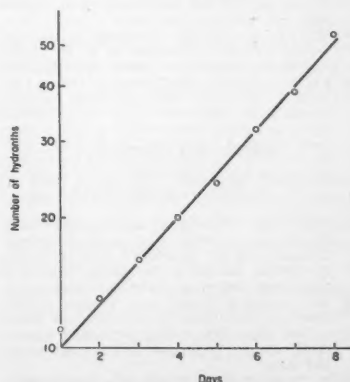


Fig. 2. Exponential growth of *Cordylophora*. A typical growth curve obtained in CCS at 22°C with one daily feeding and a second culture solution change, plotted on semilogarithmic paper. The interpolated doubling time is 3.0 days.

which correlates with the size of the colonies and can be measured with time (that is, without sacrificing the colonies) is the hydranth. A count of hydranth number with time under the conditions described reveals that the number increases exponentially for as long as hydranths can be counted accurately (Fig. 2). This is also true of *Hydra*, where the new hydranths quickly separate from the parents, and the count permits the determination of growth rate by the standard equations for exponential growth (2). Whereas Loomis found the average doubling time of *Hydra* to be slightly less than 2 days, the average for *Cordylophora* is 3 days.

By using growth rate as a measure of conditions, the influence of environmental variables on the growth of *Cordylophora* has been studied (9). Except for the composition of the aqueous environment and the feeding rate, the growth rate of colonies is relatively insensitive to variation of many parameters, including light, temperature, pH, and oxygen tension.

The method described has permitted the continual asexual growth of a clone of *Cordylophora* for over 2 years, providing vigorous and uniform material for experimental studies (10).

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References and Notes

1. S. Crowell, *Physiol. Zool.* **26**, 319 (1953); C. Hauschild, *Wilhelm Roux' Arch. Entwicklungsmech. Organ.* **147**, 1 (1954); O. Kinne, *Zool. Jahrb. Abt. Allgem. Zool. Physiol. Tiere* **66**, 565 (1956).
2. W. F. Loomis, *Science* **117**, 565 (1953); *J. Exptl. Zool.* **126**, 223 (1954).
3. G. J. Allman, *Phil. Trans. Roy. Soc. London* **143**, 367 (1853).
4. Addition of 1.5×10^{-4} molar disodium diethylenediamine tetraacetate ("versenate") chelates heavy metals and makes it possible to prepare CCS5 in tap or distilled water.
5. H. M. Lenhoff and J. Bovaird, *Anat. Record* **134**, 598 (1959).
6. *Artemia* are handled according to the controlled procedures described by W. F. Loomis and H. M. Lenhoff, *J. Exptl. Zool.* **132**, 555 (1956). *Artemia* were found to hatch inefficiently in their NaCl-tap water solution (made with either New York City or Woods Hole tap water) unless versenate and a buffer were added. To prepare a 30 X stock hatching solution, the following are added to 3200 ml of hot tap water: 345.6 gm of NaCl, 4.8 gm of disodium versenate, and 9.6 gm of NaHCO_3 .
7. With daily feeding, a second daily CCS5 change is essential for vigorous growth. Colonies can be maintained without feeding for several months if the culture solution is kept clean and evaporation is avoided.
8. Silk thread is wound once around a slide, about an inch above the bottom, and sealed to one edge with a drop of molten wax. A single upright is slipped between the thread and slide.
9. A report of these studies is in preparation.
10. I wish to thank Dr. Norton Zinder for his helpful suggestions during the course of this work, and Dr. W. F. Loomis for a critical reading of the manuscript.

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9 May 1960

Long-Range Detection of French Nuclear Tests of 1960

Abstract. With a relatively small number of strategically located ground-level air-filter stations, it has been possible to detect the presence of radioactive debris from the French nuclear test of February 1960 at a great distance from the test site, and to obtain data on the time of arrival of this debris and the extent of its north-south spread.

An atomic device of 60 to 80 kilotons' yield was fired by the French Government in the Sahara Desert near lat. 26°N , long. 0° at 0700 hours on 13 February 1960 when, according to news reports, weather conditions were such that all radioactive debris would be transported in an easterly direction. This debris would thus have to travel about three-quarters of the distance around the earth before it would intersect the 80th meridian network of air-filter stations operated by the U.S. Naval Research Laboratory (1, 2).

As is shown in Fig. 1, the station at Miraflores, Panama Canal Zone, received the first indication of fission products from this test in the 2-day collection of 24-26 February, 12 or 13 days after shot time. The time of arrival at San Juan, Puerto Rico; Miami, Fla.; and Guayaquil, Ecuador, was a day or

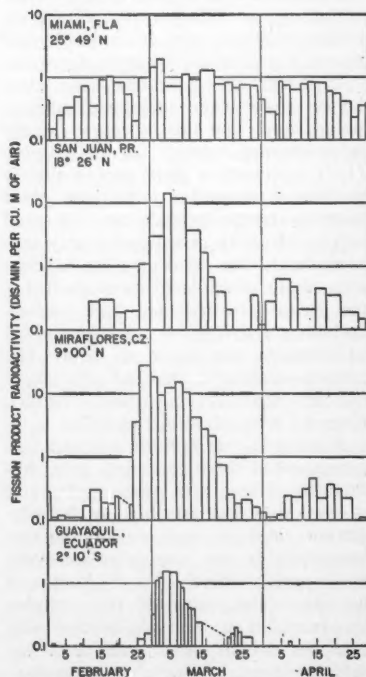


Fig. 1. Changes in the concentration of fission product radioactivity in the air along the 80th meridian (west) following the French nuclear tests of 1960.

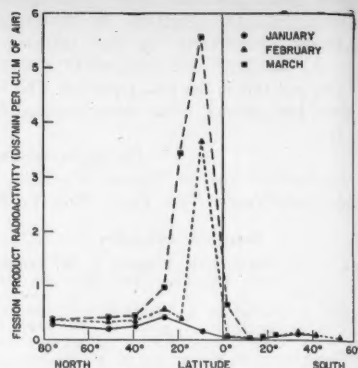


Fig. 2. Gross fission product β -activity in the air at ground level along the 80th meridian (west) during early 1960.

two later. Fission product activity reached its highest level at Miraflores in the collection of 26-29 February, when it was about 100 times the previous background of residual activity from past tests. Maxima occurred at the other sites at later times: Miami, 2-4 March; San Juan, 4-6 March; Guayaquil, 3-5 March. The second rise shown, during early April, is also probably related to the February test, since debris from the French test of 1 April would not be expected to arrive so soon. Debris from the much smaller second test could be hidden by residual activity from the first test; in any event its presence was not confirmed at any of these sites.

The extreme spread of this activity at the 80th meridian is shown in Fig. 2 to range from a few degrees south of the equator to just above lat. 25°N . No fresh activity was detected at Lima, Peru, or Washington, D.C., or at any stations north or south of these points. Conclusive proof of the absence of fresh debris at these other sites has been obtained through radiochemical analyses which showed the absence of the shorter-lived fission products. The progressive increase in the level of activity during the period January to March 1960 at the three northernmost stations is due to the predicted spring rise in activity in the Northern Hemisphere and is not associated with the French shot.

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References and Notes

1. L. B. Lockhart, Jr., R. A. Baus, R. L. Patterson, Jr., A. W. Saunders, Jr., *Science* **130**, 161 (1959).
2. Partial financial support of this work was supplied by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

11 July 1960

Meetings

Contractility

A correspondence has long been suspected between the contractility of biological structures such as muscle and other proteins and the long-range elastic deformability of suitably constructed high-polymer systems. More recently, a correspondence has been recognized between the deformability of such systems and cell motility, rhythmic motions of cilia, and cell mitosis.

In view of the importance of the subject to a broad range of biological phenomena on the one hand, and of newer ideas developing in the field of polymer science on the other, an international Conference on Contractility was held at Mellon Institute, Pittsburgh, 27-30 January 1960, under the joint auspices of the Office of Naval Research, the National Institute of Arthritis and Metabolic Diseases, and the Mellon Institute. Leading scientists engaged in research in these fields joined in active discussions throughout the 4 days of the conference. About 60 scientists, representing nine nations, participated; specialties ranged from physics to cell physiology.

The emphasis of the conference was on the fundamental principles and underlying physical-chemical concepts relating to contractile mechanisms. The connection with biological structures was explored by critical discussion of various contractile processes in biological systems.

Subjects of the Sessions

Sessions were devoted to the following subjects: (i) macromolecular models and thermodynamic principles; (ii) characterization of proteins involved in biological contraction; (iii) chemistry of contraction; (iv) analysis of the muscle system; and (v) contractile systems in cells and systems other than muscle. A sixth session was devoted exclusively to discussion.

Each session was opened with one or two invited lectures, which reviewed the area under consideration and pointed out the more and the less established

aspects. This was followed by shorter scheduled reports and discussion, the latter generally extending well beyond the scheduled sessions.

Physicochemical Aspects

The opening session of the conference dealt with the physicochemical aspects of contractility and the related problem of performance of mechanical work by nonliving macromolecular systems. The study of long-chain molecules has shown that it is possible to transform chemical energy directly into mechanical work and that, furthermore, the macromolecular engine provides the contractile mechanism as well. Virtually every high-polymer network consisting of long molecular chains displays the capacity to maintain very large, recoverable strains (P. J. Flory, Mellon Institute). Rotations about chain bonds endow a polymeric substance with the singular capacity to accommodate large deformations and to return under suitable conditions to the initial undeformed state. The elasticity of rubber is a good example; cross-linking of the chains prevents irreversible flow. Closely related to rubber elasticity are deformations involving changes in the degree of swelling in open thermodynamic systems.

Polymer chains of sufficiently regular structure may occur in the crystalline state (Flory; L. Mandelkern, National Bureau of Standards). Crystallization may be induced by stretching; conversely, melting may induce contraction. The transformation between crystalline and amorphous states, being a phase transition, is very sensitive to temperature and may be made correspondingly sensitive to chemical environment. Also, the deformation range of the macromolecular contractile system may be considerably increased by crystallization, or, in general, by phase transformations involving large dimensional changes at constant force.

A macromolecular contractile system which is responsive to alterations in chemical environment may serve as a macromolecular engine for transforming chemical energy into mechanical

work (W. Kuhn, University of Basel). Chemical reactions made to occur on the macromolecules themselves provide a convenient means for strongly altering the shape of linear macromolecules or the swelling capacity of cross-linked systems. Reversible ionization and deionization of suitable groups attached to the macromolecular chains provide one possible mechanism leading to appreciable osmotic driving forces. Other mechanisms, such as, for instance, changes in solubility induced by the addition and removal of complexing agents (for example, Ca^{++} ions to anionic polyelectrolyte systems), are not excluded.

In general, any thermodynamic system capable of transforming chemical energy directly into mechanical work or, conversely, of transforming mechanical into chemical energy can be described as a mechanochemical engine (A. Katchalsky, Weizmann Institute). These transformations are usually carried out by contractile fibers, which may operate cyclically, reverting after each cycle to their initial state. A thermodynamic analysis of such cycles is rewarding, as it leads to an evaluation of mechanochemical performance and establishes some general conditions for the feasibility and efficacy of mechanochemical transformations. Cycles with phase transitions at constant potential of the reactants are shown to be particularly efficacious converters of chemical energy into mechanical work.

Further contributions to this session dealt with the thermodynamics of the stretching of swollen fibers (W. Prins and J. J. Hermans, Syracuse University); recent work on the reversible supercontraction of β -keratose with change of pH (F. G. E. Pautard, University of Leeds); elastic properties of muscle proteins (C. A. J. Hoeve, Mellon Institute; Flory); evidence for a phase transition in muscle contraction (Hoeve and Flory); and the rates of configurational change in macromolecules and their dependence on concentration and charge (J. D. Ferry, University of Wisconsin).

Muscular Contraction

The study of muscular contraction illustrates different approaches to the analysis of contractility in biological systems. Experimental methods fall into five broad categories: (i) analysis of structure; (ii) chemical characterization of component proteins; (iii) enzymatic activity of the proteins; (iv) study of simpler, model systems; and (v) physiology of the intact system. The following general picture emerged from the sessions.

Electron micrographs of skeletal muscle show two morphologically distinct sets of filaments, thick (A band)

and thin (I band). At normal muscle length, the thin filaments extend beyond the I band and interdigitate with thick filaments in the A band. In longitudinal sections the interdigitating array can be seen directly; it can also be deduced from counts of the number of filaments in successive cross sections. Although some recent micrographs suggest that the two sets of overlapping myofilaments are not always separate (F. S. Sjostrand, Karolinska Institute), most subsequent discussion of contractile mechanism was premised on the interdigitating anatomy.

Of the structural proteins that can be extracted from muscle, myosin and actin are fairly well characterized (K. Laki, National Institutes of Health). However, it is difficult to work out exact relationships among operationally defined muscle proteins because the preparations are not homogeneous, especially when tested immunologically. The heterogeneity can be reduced considerably by making ammonium sulfate precipitations in the presence of lithium chloride (J. Marshall, University of Pennsylvania).

Myosin and actin appear to be localized in the thick and thin myofilaments, respectively. This assignment is based on differential extractability of A- and I-band material (J. Hanson, University of London) and staining studies with fluorescent antibodies (Marshall).

The muscle proteins are chemically reactive: they form complexes with each other and also interact with smaller molecules, notably the nucleotides. Although it is not clear how these reactions relate to the contractile process, they are of interest because they reflect properties of components of muscle. One such reaction frequently implicated in the contractile process is the hydrolysis of adenosinetriphosphate (ATP) by myosin and actomyosin. Studies with labeled substrate suggest that the terminal phosphate of the nucleotide is transferred to the enzymatic site of the protein before being liberated as inorganic phosphate (D. Koshland, Brookhaven National Laboratory).

Under appropriate conditions, actin alone splits ATP (F. Oosawa, Nagoya University). The G-F transformation, from globular actin to fibrous aggregates, can be regarded as a reversible fibrous condensation. The apparent equilibrium state depends on magnesium concentration and temperature; it is accompanied by a continuous dephosphorylation of ATP and is, therefore, a steady state maintained by ATP hydrolysis. Another aspect of the interaction of actin with nucleotide is the exchange of bound nucleotide with labeled ATP or adenosinediphosphate in the solution. In the G form, exchange of ATP takes place; however,

the nucleotide in the F form is not exchangeable (J. Gergely, Massachusetts General Hospital).

Many properties of living muscle can be demonstrated after the physiological regulatory mechanisms have been destroyed by treatment with glycerol. The contractile response of the glycerol-extracted preparation is elicited by ATP and other triphosphorylated nucleotides; both actin and myosin are required (A. Szent-Gyorgyi, Institute for Muscle Research). The nature of the forces leading to this contraction is not known.

Further contributions to the biochemistry of muscle dealt with studies on the structure of myosin which indicate that it is a triply stranded polypeptide chain (W. Kielley and W. F. Harrington, National Institutes of Health); the inhibition of adenosinetriphosphatase activity of myosin A with trinitrobenzene sulfonate (a specific ϵ -amino group reagent) and the interaction of myosin B with pyrophosphate and ATP (Y. Tonomura, Hokkaido University); the activation and inhibition of myosin A (J. J. Blum, Baltimore City Hospitals); the intrinsic contractibility of the myosin B system (M. F. Morales, Dartmouth Medical School); and the dependence of the rate of creatine phosphate hydrolysis on the rate of muscular contraction (W. F. H. M. Mommaerts, University of California).

The physiology of striated muscle can be interpreted in terms of both *sliding* and *folding* mechanisms (R. J. Podolsky, Naval Medical Research Institute). According to the former interpretation, contraction is brought about by mechanical interaction of the two sets of filaments seen in electron micrographs. In the folding model, the contractile force arises from molecular rearrangement of a single filament. Feedback between the mechanical motion and the chemical process which leads to this molecular rearrangement can account for both the steady-state and transient properties of the living fiber.

Smooth muscle also has two morphologically distinct myofilaments; this suggests that, if the contractile force arises from interaction between filaments, the same fundamental mechanism might work in both smooth and striated muscles (J. Hanson, University of London).

Other examples of contractibility in biological systems are the movement of chromosomes in cell division (S. Inoue, Dartmouth Medical School), the injection of virus genetic material into bacteria (L. Kozloff, University of Chicago), the movement of sperm tails (B. Afzelius, Wenner Grens Institute), and protoplasmic streaming (N. Kamiya, Osaka University). Several similarities to the muscle system were noted. For example, some physical-

chemical properties of the fibers that control chromosome movement resemble those of actin (D. Mazia, University of California). Also, the protein which moves virus material into the host cell is similar to actomyosin; ATP is hydrolyzed when the protein contracts. Lastly, cellular contractile elements can be studied as model systems after glycerol extraction (H. Hoffman-Berling, Max Planck Institut für Physiologie). As in similar preparations of muscle, motility can be influenced by the concentration of ATP, calcium, and mercurial inhibitors.

Sliding versus Folding

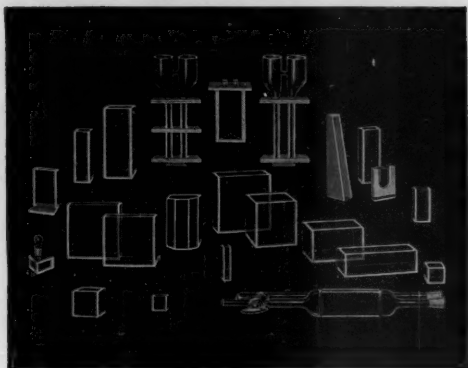
The final session of the conference was largely devoted to discussion. The issue of a sliding mechanism versus one of chain "folding" in muscular contraction evoked spirited response. According to the former view, contraction is brought about by interactions at the surfaces of filaments revealed in electron microscopy; both the molecular arrangement and the linear dimension of the filaments are considered to remain unaltered. Opponents preferred one or another of several mechanisms involving configurational rearrangements at the molecular level, these rearrangements occurring within the filaments of the sarcomere. According to these views the linear dimensions of the filaments decrease as the muscle shortens. Electron micrographs of muscles stopped at different stages of isotonic contraction offer the possibility of distinguishing between the two mechanisms; several laboratories are undertaking studies of this nature.

A contractile force could be generated, it was stated, by a sliding model in which the number of filament bonds increases with the extent of interdigitation (W. Kauzmann, Princeton University). Flory questioned the sufficiency of simple surface interactions to generate forces and deformations of the magnitudes observed, stating that linkages capable of sustaining the required tensions would probably not be labile enough to facilitate the observed rapid alterations in lengths. Podolsky noted that it would be difficult to reconcile such a sliding model with the kinetics of muscular contraction. Sliding kinematics in which the moving filaments have complementary sites which, as they pass each other, form a mechanochemical engine remains a possibility. In this case, although the contractile force would be produced by changes in molecular configuration, the filaments on which the force-generating elements are situated would "slide" past each other.

If chemical reactions can be reversed in contracting muscle during an applied stretch, as suggested by A. V. Hill, forcible stretching apparently brings about *microscopic* reversal of the con-

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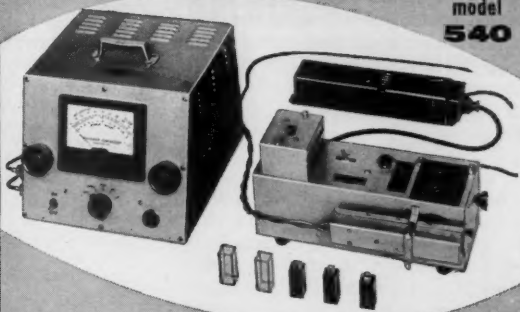
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tractile process. This is easy to understand if contraction of a fiber is brought about by the adsorption of a substance distributed between fiber and immersing solution, as discussed earlier by Katchalsky. However, it is not easy to visualize the microscopic reversal (by sudden stretch) of a process consisting of several cycles of dephosphorylation, as in some mechanisms proposed for shortening by sliding filaments (M. F. Morales).

Other Discussion

Further discussion posed the question of how to differentiate the several molecular mechanisms whereby long molecules may induce major changes in dimensions through interaction with a chemical reagent. One mechanism, discussed earlier by Flory and Mandelkern, depends on the existence of the polymer in two forms, crystalline and amorphous, the one form being converted into the other upon alteration of the chemical environment. Coexistence of the two forms would, under the simplest circumstances, be evidenced by a horizontal region in the isothermal stress-strain curve. T. Hill (University of Oregon) pointed out that such a stress-strain curve does not necessarily imply a crystalline-amorphous transition; there are other molecular mechanisms which result in similar stress-strain curves. J. J. Hermans said that whether a one- or two-phase description of a system is used is a matter of convenience. If a cooperative transition is involved, it is generally expeditious to treat the phenomenon as a phase transition.

H. Eisenberg (Mellon Institute) discussed the profound difference in the effects of potassium chloride and sodium chloride in producing phase transitions in some synthetic polyelectrolytes, under conditions of identical charge density; F. Oosawa reported similar findings in the influence of magnesium and calcium on the phase transition of polyacrylic acid.

In the course of the conference it became clear that a number of biological processes can be interpreted in terms of long-range elastic deformation of polymers. In no case, though, is the evidence for this mechanism conclusive; contraction preceded by an interaction between polymers could not be excluded. However, the lines of research by which these mechanisms might be distinguished were brought into sharper focus.

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Forthcoming Events

September

6-10. Lower Metazoa, Comparative Biology and Phylogeny, 2nd symp., Asilomar, Pacific Grove, Calif. (M. B. Allen, Kaiser Foundation Research Inst., 14th and Cutting Blvd., Richmond, Calif.)

8-9. Technical Communications, 2nd annual, Dayton, Ohio. (D. G. Peterson, Jr., Soc. of Technical Writers and Editors, 4564 Marlin Ave., Dayton 16, Ohio)

8-10. American Political Science Assoc., New York, N.Y. (E. M. Kirkpatrick, 1726 Massachusetts Ave., NW, Washington 6, D.C.)

8-10. Great Issues of Conscience in Modern Medicine, Hanover, N.H. (G. O'Connell, Dartmouth College News Service, Hanover)

8-10. Parapsychological Assoc., 3rd. annual, New York, N.Y. (W. G. Roll, Parapsychology Laboratory, Duke Univ., Durham, N.C.)

8-18. History of Medicine, 17th intern. cong., Athens and Isle of Cos, Greece. (S. Oeconomos, Faculty of Medicine, National and Capodistrian Univ. of Athens, Odos panepistimiou, Athens, Greece)

10-11. Air Pollution, intern. cong., New York, N.Y. (A. B. Conlin, Jr., ASME, 29 W. 39th St., New York 18)

11-15. International College of Surgeons, 12th intern. cong., New York, N.Y. (M. Thorek, ICS, 850 W. Irving Park Rd., Chicago 13, Ill.)

11-16. American Chemical Soc., 138th annual, New York, N.Y. (A. T. Winstead, ACS, 1155 16th St., NW, Washington 6)

11-16. Illuminating Engineering Soc., natl. technical conf., Pittsburgh, Pa. (A. D. Hinkley, IES, 1860 Broadway, New York 23)

12-13. International Conf. on Trichinellosis, Warsaw, Poland. (Z. Kozar, Polish Parasitological Soc., Zaklad Parazytologii, PAN, Warszawa, Pasteura 3, Poland)

12-14. Entomological Soc. of Canada—Entomological Soc. of Saskatchewan, annual joint meetings, Saskatoon, Sask., Canada. (L. L. Reed, ESC, K. W. Neatby Bldg., Carling Ave., Ottawa, Canada)

12-15. Atomic Masses, intern. conf., Hamilton, Ontario, Canada. (H. E. Duckworth, Dept. of Physics, McMaster Univ., Hamilton)

12-15. Society of Automotive Engineers, Milwaukee, Wis. (R. W. Crory, SAE, Meetings Operation Dept., 485 Lexington Ave., New York 17)

12-16. International Council of the Aeronautical Sciences, 2nd intern. cong., Zurich, Switzerland. (J. B. Bidwell, Inst. of the Aeronautical Sciences, 2 E. 64 St., New York 21)

12-17. World Federation of Occupational Therapists, Sydney, Australia. (Liverpool School of Occupational Therapy, Victoria Rd., Huyton, Liverpool, England)

13-14. Bionics, symp., Dayton, Ohio. [Commander, Wright Air Development Division, Attention: WWRDA (Maj. J. E. Steele, Wright-Patterson Air Force Base, Ohio)]

13-15. Instruments and Measurements, 5th intern. conf., Stockholm, Sweden. (Tekn. Lic. Helge von Koch, Kungl. Tekniska Högskolan, Stockholm 70)

14-15. Aspects of Internal Irradiation

of Mammals, Saratoga, Wyo. (T. F. Dougherty, Univ. of Utah, Salt Lake City)

14-16. Tube Techniques, 5th natl. conf., New York, N.Y. (D. Slater, College of Engineering, Research Div., New York Univ., 346 Broadway, New York 13)

15-16. Engineering Management Conf., 8th annual, Chicago, Ill. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18)

15-17. Radio Soc. of Great Britain, natl. convention, Cambridge, England. (Secretary, RSGB Convention Committee, 37 Metcalfe Rd., Cambridge, England)

16-18. Cori's Ester and Phosphorylated Glucides, 1st intern. symp., Milan, Italy. (Segreteria Organizzativa del 1st Symposium Internazionale sull'estere di Cori e sui glucidi fosforilati, Via Modica 6, Milan)

16-21. European Cong. on Infantile Neuro-Psychiatry, Paris, France. (G. Beaubre, 14 rue Drouot, Paris)

16-22. World Medical Assoc., Berlin, Germany. (General Secretary, WMA, 10, Columbus Circle, New York 19)

18-21. Forensic Pathology, 2nd intern., New York, N.Y. (C. Larsen, Tacoma General Hospital, Tacoma 5, Wash.)

18-25. Inter-European Cong. of Cardiology, 3rd, Rome, Italy. (V. Puddu, Clinica, Medica, Università-Policlinico, Rome)

19-21. Space Electronics and Telemetry, 5th natl. symp., Washington, D.C. (H. W. Royce, Glenn L. Martin Co., Mail Stop H-2035, Baltimore 3, Md.)

19-22. Research in Burns, 1st intern. cong., Bethesda, Md. (American Inst. of Biological Sciences, 2000 P St., NW, Washington 6)

20-23. Conf. on Pure Food Laws, London, England. (Secretariat, Pure Food Centenary 1960, 14 Belgrave Sq., London S.W.1)

20-24. Aeronautics, 4th European cong., Cologne, Germany. (Wissenschaftliche Gesellschaft für Luftfahrt, Eberplatz 2, Cologne)

20-7. International Atomic Energy Agency, 4th general conf., Vienna, Austria. (IAEA, 11 Kärntner Ring, Vienna 1)

21-22. Industrial Electronics, 9th annual symp., Cleveland, Ohio. (G. E. Hindley, Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17)

21-23. National Power Conf., Philadelphia, Pa. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

22. Society of Plastics Engineers, Binghamton, N.Y. (T. A. Bissell, SPE, 65 Prospect St., Stamford, Conn.)

22-23. High Temperature Resistance and Thermal Degradation of Polymers, symp., London, England. (Symposium Subcommittee, Plastics and Polymer Group, Soc. of Chemical Industry, 14, Belgrave Sq., London, S.W.1)

22-26. Cancer Cytology, intern. conf., Madrid, Spain. (Miss E. L. Hughes, Pan American Cancer Cytology Soc., P.O. Box 633, Coral Gables, Fla.)

23-25. Inter-Society Cytology Council, annual, Chicago, Ill. (P. A. Younge, ISCC, 1101 Beacon St., Brookline 46, Mass.)

24-2. American Soc. of Clinical Pathologists, Chicago, Ill. (A. H. Dearing, 2115 Prudential Plaza, Chicago, Ill.)

25-28. American Inst. of Chemical Engineers, Tulsa, Okla. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36)

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25-30. North American Assoc. of Alcoholism Programs, 11th annual conf., Banff, Alberta, Canada. (J. G. Strachan, Alcoholism Foundation of Alberta, 9910 103rd St., Edmonton, Alberta, Canada)

26-28. American Inst. of Electrical Engineers, petroleum industry conf., Oklahoma City, Okla. (R. S. Gardner, AIEE, 33 W. 39 St., New York 18)

26-28. American Soc. of Mechanical Engineers, petroleum mechanical engineering conf., New Orleans, La. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

26-28. Electronic Industries Assoc., natl. conv., Pittsburgh, Pa. (V. M. Graham, EIA, 11 W. 42 St., New York 36)

26-28. Standards Engineers Soc., annual, Pittsburgh, Pa. (J. A. Caffiaux, SES, 11 W. 42 St., New York 36)

26-30. Instrument Soc. of America, New York, N.Y. (W. H. Kushnick, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

26-1. Natural Rubber Research Conf., Kuala Lumpur, Malaya. (Rubber Research Inst. of Malaya, P.O. Box 150, Kuala Lumpur)

27-29. Relative Humidity and Paper Test Methods, symp., Grand Rapids, Mich. (Technical Assoc. of the Pulp and Paper Industry, 155 E. 44 St., New York 17)

27-30. American Rocket Soc.—Power Systems Conf., Santa Monica, Calif. (R. L. Hohl, ARS, 500 Fifth Ave., New York 36)

27-30. American Roentgen Ray Soc., Atlantic City, N.J. (N. Jones, 20 N. Wacker Dr., Chicago 6, Ill.)

27-30. Association of Iron and Steel Engineers, annual conv., Cleveland, Ohio. (T. J. Ess, AISE, 1010 Empire Bldg., Pittsburgh, 22, Pa.)

27-30. Medical Photography, 1st intern. cong., Cologne, Germany. (Deutsche Gesellschaft für Photographie e.V., Köln, Nurmmarkt 49, Germany)

28-1. International Soc. of Audiology, 5th cong., Bonn, Germany. (Prof. Langenbeck, Baumschuallee 29, Bonn)

28-5. Pan-Pacific Surgical Assoc., 8th cong., Honolulu, Hawaii. (F. J. Pinkerton, 230 Alexander Young Bldg., Honolulu 13)

30-1. American College of Radiology, Atlantic City, N.J. (F. H. Squire, Presbyterian-St. Luke's Hospital, 1753 W. Congress St., Chicago 12, Ill.)

30-1. American Medical Writer's Assoc., Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

October

1-2. Enzymes in the Manufacture, Storage and Distribution of Food, symp., London, England. (Society of Chemical Industry, 14 Belgrave Sq., London, S.W. 1)

2-5. American Inst. of Mining, Metallurgical and Petroleum Engineers, fall, Denver, Colo. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18)

2-6. Water Pollution Control Federation, 33rd annual, Philadelphia, Pa. (WPCF, 4435 Wisconsin Ave., Washington 16)

2-7. American Soc. of Plastic and Reconstructive Surgery, Los Angeles, Calif. (T. R. Broadbent, 508 E. S. Temple, Salt Lake City, Utah)

3-5. Applied Spectroscopy, 7th symp., Ottawa, Canada. (C. R. Langdon, Alu-

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Program Content

1. The two-session AAAS General Symposium, "Moving Frontiers of Science V"—Speakers: Edward Anders, H. W. Magoun, George Wald, and H. H. Goldstine; Thomas Park, presiding.
2. The "Challenge to Science" evening with Sir Charles P. Snow, Theodore M. Hesburgh, and W. O. Baker; Warren Weaver, presiding.
3. On "AAAS Day," the three broad, interdisciplinary symposia—Plasma: Fourth State of Matter; Life under Extreme Conditions; and Urban Renewal and Development, arranged by AAAS Sections jointly.
4. The Special Sessions: AAAS Presidential Address and Reception; Joint Address of Sigma Xi and Phi Beta Kappa by Polykarp Kusch; the Tau Beta Pi Address; National Geographic Society Illustrated Lecture; and the first George Sarton Memorial Address by René Dubos.
5. The programs of all 18 AAAS Sections (specialized symposia and contributed papers).
6. The programs of the national meetings of the American Astronomical Society, American Nature Study Society, American Society of Zoologists, History of Science Society, National Association of Biology Teachers, Scientific Research Society of America, Sigma Delta Epsilon, Society for General Systems Research, Society for the Study of Evolution, Society for the History of Technology, Society of Systematic Zoology, and the Society of the Sigma Xi.
7. The multi-session special programs of the American Association of Clinical Chemists, American Astronautical Society, American Geophysical Union, American Physiological Society, American Psychiatric Association, American Society of Criminology, Association of American Geographers, Ecological Society of America, Mycological Society of America, National Science Teachers Association, New York Academy of Sciences—and still others, a total of some 90 participating organizations.
8. The four-session program of the Conference on Scientific Communication: The Sciences in Communist China, cosponsored by the AAAS, NSF, and ten societies.
9. The sessions of the Academy Conference, the Conference on Scientific Manpower, and the conference of the American Council on Women in Science.
10. The sessions of the AAAS Cooperative Committee on the Teaching of Science and Mathematics, and of the AAAS Committee on Science in the Promotion of Human Welfare.
11. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
12. Exhibitors in the 1960 Annual Exposition of Science and Industry—103 booths—and descriptions of their exhibits.

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3-5. Communications, 6th natl. symp., Utica, N.Y. (B. H. Baldrige, Communications Symp., Light Military Electronics Dept., General Electric Co., Utica)

3-5. Nuclear Science, 7th annual, Gatlinburg, Tenn. (H. E. Banta, Oak Ridge National Lab., P.O. Box X, Oak Ridge, Tenn.)

3-7. Atomic Energy, 5th intern. seminar, Wiesbaden, Germany. (Mr. Trebst, Diplom-Volkswirt, Generalsekretär, Internationale Studiengesellschaft e.V., Theodorenstr. 6-8, Wiesbaden)

4-6. Radio Interference Reduction, 6th conf., Chicago, Ill. (S. I. Cohn, Armour Research Foundation, 10 W. 35 St., Chicago)

4-7. Recent Developments in Research Methods and Instrumentation, 10th annual symp., Bethesda, Md. (J. B. Davis, Natl. Institutes of Health, Bethesda 14)

5-7. Accelerator Conf., Amsterdam, Netherlands. [J. S. Woldringh, High Voltage Engineering (Europa) N.V., Amersfoort, Netherlands]

5-8. American Acad. of Cerebral Palsy, 14th annual, Pittsburgh, Pa. (J. D. Russ, 1520 Louisiana Ave., New Orleans 15, La.)

6-10. American Assoc. of Textile Chemists and Colorists, natl. conf., Philadelphia, Pa. (G. P. Paine, AATCC, P.O. Box 28, Lowell, Mass.)

6-8. Clay Conf., 9th natl., Lafayette, Ind. (J. L. White, Agronomy Dept., Purdue Univ., Lafayette)

6-8. Society of Experimental Test Pilots, annual symp., Los Angeles, Calif. (SETP, 44919 N. Cedar Ave., Lancaster, Calif.)

8. Helminthological Soc. of Washington, 50th, College Park, Md. (Publicity Committee, HSW, Animal Disease and Parasite Research Branch, ARS, U.S. Department of Agriculture, Beltsville, Md.)

9-13. Electrochemical Soc., Houston, Tex. (Electrochemical Soc., 216 W. 102 St., New York 25)

9-14. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 15 Second St., S.W., Rochester, Minn.)

10-12. Human Factors and Bioastronautics, conf., Dayton, Ohio. (J. J. Harford, American Rocket Soc., 500 Fifth Ave., New York 36)

10-12. Industrial Health, cong., Charlotte, N.C. (Council on Occupational Health, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

10-12. National Electronics, conf., Chicago, Ill. (T. F. Jones, Jr., School of EE, Purdue Univ., Lafayette, Ind.)

10-12. Operations Research Soc. of America, natl., Detroit, Mich. (H. J. Miser, ORSA, Research Triangle Inst., 505 W. Chapel Hill St., Durham, N.C.)

10-14. American College of Surgeons, San Francisco, Calif. (W. E. Adams, 40 E. Erie St., Chicago 11, Ill.)

10-14. American Soc. of Civil Engineers, annual conv., Boston, Mass. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18)

11-13. Applications of Nuclear Energy, conf., Karlsruhe, Germany. (Ing. Küpfmüller, Deutsches Atomforum, Friedrichstr. 2 III, Düsseldorf, Germany)

11-13. Synthetic Rubber, 2nd intern. symp., London, England. (Rubber and Plastics Age, Gaywood House, Great Peter St., London, S.W. 1)

11-14. Audio Engineering Soc., 12th annual conv., New York, N.Y. (H. F. Olson, RCA Laboratories, Princeton, N.J.)

11-14. Inelastic Scattering of Neutrons in Solids and Liquids, symp., Vienna, Austria. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

12-13. American Vacuum Soc., 7th natl. symp., Cleveland, Ohio. (AVS, Box 1281, Boston 9, Mass.)

12-14. Astronautics, 3rd annual symp., Los Angeles, Calif. (Maj. G. Colchagoff,

Propulsion Div., Air Force Office of Scientific Research, Washington 25)

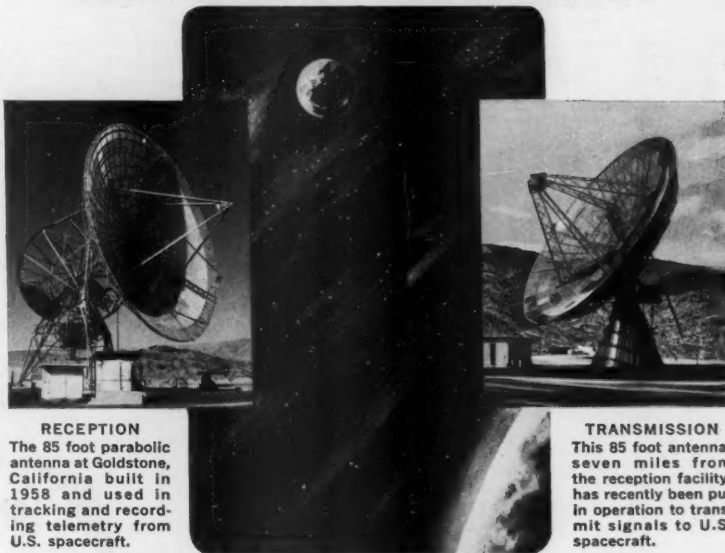
12-14. Gaseous Electronics, 13th annual conf., Monterey, Calif. (N. L. Ole-son, U.S. Naval Postgraduate School, Monterey)

12-14. Nuclear Reactor Chemistry, conf., Gatlinburg, Tenn. (C. D. Susano, Oak Ridge National Lab., P.O. Box Y, Oak Ridge, Tenn.)

13-15. Academy of Psychosomatic Medicine, Philadelphia, Pa. (B. B. Moss, 55 E. Washington, Chicago 2, Ill.)

13-14. Engineering Writing and Speech, natl. symp., Chicago, Ill. (M. Whitmer, Admiral Corp., 3800 W. Cortland St., Chicago 47)

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14-15. Society of Photographic Scientists and Engineers, symp., Washington, D.C. (F. M. Brown, Photomechanisms, Inc., Box 67, Huntington Station, N.Y.)

15. American Soc. of Safety Engineers, annual, Chicago, Ill. (A. C. Blackman, ASSE, 5 N. Wabash Ave., Chicago 2)

16. American College of Dentists, Los Angeles, Calif. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis 8, Mo.)

16-22. High-Speed Photography, 5th intern. cong., Washington, D.C. (V. H. Allen, Soc. of Motion Picture and Television Engineers, 55 W. 42 St., New York 36)

16-22. Society of Motion Picture and Television Engineers, semi-annual conv., Washington, D.C. (C. S. Stodter, SMPTE, 55 W. 42 St., New York 36)

17-19. Adaptive Control Systems, symp., New York, N.Y. (H. Levenstein, W. L. Maxon Corp., 260 W. 34 St., New York)

17-19. American Oil Chemists' Soc., fall, New York, N.Y. (W. C. Ault, U.S. Department of Agriculture, Philadelphia 18, Pa.)

17-20. American Acad. of Pediatrics, Chicago, Ill. (E. H. Christopherson, 1801 Hinman Ave., Evanston, Ill.)

17-20. American Dental Assoc., Los Angeles, Calif. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago, Ill.)

17-21. Neutron Pile Research, symp., Vienna, Austria. (International Atomic

Energy Agency, 11 Kärntner Ring, Vienna 1)

17-22. Diagnosis and Treatment of Acute Radiation Injury, Geneva, Switzerland. (World Health Organization, Palais de Nations, Geneva)

17-26. Plastics Processing, intern. cong. and exhibition, Amsterdam and Utrecht, Netherlands. (Secretariat, c/o N. V. 't Raedthuys, Tesselschadestraat 5, Amsterdam-W, Netherlands)

18. Oak Ridge Inst. of Nuclear Studies, Oak Ridge, Tenn. (W. G. Pollard, Box 117, Oak Ridge)

18-21. American Dietetic Assoc., 43rd annual, Cleveland, Ohio. (M. L. Ross, Simmons College, The Fenway, Boston 15, Mass.)

19-20. American Geophysical Union, Moscow, Idaho. (A. N. Sayre, U.S. Geological Survey, Washington 25, D.C.)

19-21. Design of Experiments, 6th conf. (by invitation only), Aberdeen Proving Ground, Md. (F. G. Dressel, Office of Ordnance Research, Box CM, Duke Station, Durham, N.C.)

19-21. Space Navigation, symp., Columbus, Ohio. (Institute of Radio Engineers, 1 E. 79 St., New York 21)

19-26. Measuring Techniques and Automation, 2nd intern. cong., Düsseldorf, Germany. (Nordwestdeutsche Ausstellungs-Gesellschaft, Ehrenhof 4, Düsseldorf)

20-21. Hypervelocity, symp., Denver, Colo. (R. R. Dexter, IAS, 2 E. 64 St., New York 21)

20-22. Acoustical Soc. of America,

San Francisco, Calif. (V. Salmon, Stanford Research Inst., Menlo Park, Calif.)

20-22. Institute of Management Sciences, 7th intern., New York, N.Y. (J. Townsend, IMS, 30 E. 42 St., New York 17)

21-22. Research Approaches to Psychiatric Problems, symp., Galesburg, Ill. (T. T. Tourlentes, Galesburg State Research Hospital, Galesburg)

21-25. American Heart Assoc., annual, St. Louis, Mo. (AHA, 44 E. 23 St., New York 10)

22. Midwest Solid State Conf., 8th annual, Lincoln, Neb. (J. W. Weymouth, Physics Dept., Univ. of Nebraska, Lincoln)

23-26. American College of Gastroenterology, Philadelphia, Pa. (D. Weiss, 33 W. 60 St., New York 23)

24-27. Hot Atom Effects, symp., Prague, Czechoslovakia. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

25-27. American Standards Assoc., natl. conf., New York, N.Y. (G. F. Hussey, Jr., AST, 70 E. 45 St., New York 17)

26-28. Society for Industrial Microbiology, Conf. on Antimicrobial Agents, Washington, D.C. (SIM, 2000 P St., NW, Washington 6)

27-28. Cellulose Conf., 3rd, Syracuse, N.Y. (Cellulose Research Inst., State Univ. College of Forestry, Syracuse Univ., Syracuse 10)

27-28. Electron Devices, 6th annual, Washington, D.C. (J. Hornbeck, Bell Telephone Labs., Murray Hill, N.J.)

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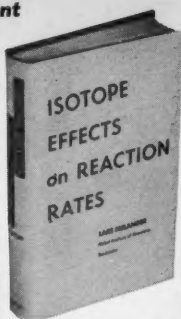
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The Beginnings of Embryonic Development

AAAS Symposium Volume No. 48

1957

Edited by Albert Tyler, California Institute of Technology
R. C. von Borstel, Oak Ridge National Laboratory
Charles B. Metz, The Florida State University

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A symposium on "Formation and Early Development of the Embryo", held 27 December 1955, at the Second Atlanta Meeting of the AAAS, served as the basis for this volume. Emphasis was placed on the problems of early development and of the initiation of development. The investigations presented in the various communications cover both descriptive and experimental work on the biological and chemical levels. Apart from their intrinsic interest and the measure of progress that they provide, the specific discoveries and analyses presented serve to exemplify various approaches toward the understanding of the manner in which sperm and egg contrive to produce a new individual.

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New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.

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■ **PULSE GENERATOR** produces positive and negative output pulses with widths of 2 μ sec to 20 μ sec and amplitude adjustable between 0 and 15 volts into a 50-ohm load. The unit contains a variable repetition rate generator, 1 to 1000 cy/sec, and two fixed-frequency sources of 1 and 10 cy/sec. Accuracy of the fixed frequencies is that of the power line frequency. (Alto Scientific Co., Dept. Sci720, 858 Commercial St., Palo Alto, Calif.)

■ **VIBRATION TRANSMISSIBILITY RECORDER** records transmissibility directly as a function of frequency. The recorder simultaneously accepts two synchronous signals in the frequency range 10 to 5000 cy/sec, measures their frequency, computes the average amplitude values and plots the ratio versus frequency. The instrument can be used to record input voltage, time integral of input voltage, or time derivative of input voltage. Four scale ranges are provided. Sensitivity is continuously adjustable. (Lord Manufacturing Co., Dept. Sci700, Erie, Pa.)

■ **DELAY CABLE** features impedance of 1500 ohms and delay of 0.08 μ sec/ft. Ratios of delay-to-rise time of 100 to 1 are said to be achievable. Cable diameter is 0.4 in. It can be supplied in 100-ft lengths or in calibrated sections. (Columbia Technical Corp., Dept. Sci701, 61-02 31st Avenue, Woodside 77, N.Y.)

■ **DIGITAL READOUT DEVICE** forms illuminated characters by light passing through holes in opaque coating on two plates. Motion of the plates relative to one another aligns various prearranged holes and permits light from a rear-mounted lamp to pass through, forming the characters. Movement of the plates is controlled by four electromagnets, allowing choice of 16 characters. Display response time is said to be less than 50 msec. (Genesys Corp., Dept. Sci704, 10131 National Blvd., Los Angeles 34, Calif.)

■ **TUNNEL-DIODE CURVE TRACER** is used with a laboratory oscilloscope to present current-voltage characteristics of tunnel diodes throughout the negative resistance region. A four-position switch adjusts scale factor of the transformation from current to voltage for vertical deflection and simultaneously changes shunt impedance on the diode. Accuracy of conversion is ± 1 percent. (Trak Electronics Co., Dept. Sci705, Wilton, Conn.)

■ **AUTOMATIC CHROMATOGRAM SCANNER** is designed specifically for scanning tritium and other weak beta emitting isotopes. The scanner uses windowless 4 π detection. The instrument is completely transistorized. (Vanguard Instrument Co., Dept. Sci706, P.O. Box 244, La Grange, Ill.)

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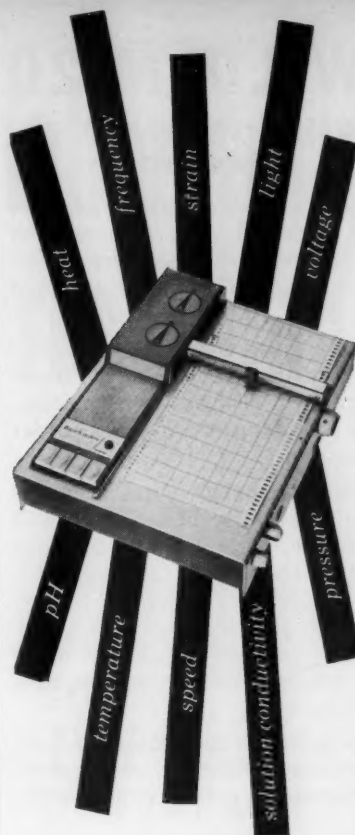
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JOSHUA STERN

National Bureau of Standards,
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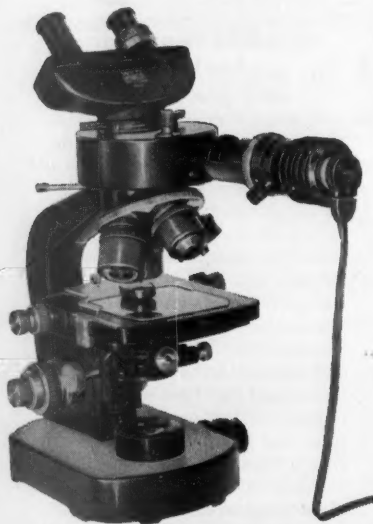
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Letters

American Astronautical Society

I recently read in the news section of *Science* [131, 1658 (1960)] the item on the new International Academy of Astronautics, established by a Guggenheim grant. In the interest of accurate reporting and courtesy, I should like to point out a glaring error in this note. In describing the International Astronautical Federation, the item states, "The United States member, the American Rocket Society . . .," implying a single member from the U.S. This is incorrect. There are, in fact, three American societies in the federation. In addition to the American Rocket Society, the American Astronautical Society has been a member since 1954, and in 1959 the Aerospace Medical Association was elected to membership.

The American Astronautical Society is the only American society devoted solely to the advancement of astronautics and was the first in this country to offer comprehensive technical programs in all fields of astronautics. It has also been very active in IAF activities through committee work in the past years.

GEORGE R. ARTHUR

American Astronautical Society,
New York, New York

Federal and State Support of Science

The issue of *Science* for 22 April contained several unusually interesting and significant articles. Particularly noteworthy was the excerpt from *Notes on the Reviewing of Learned Books* [131, 1182 (1960)] by the late George Sarton. The procedures outlined by Sarton are such as to deserve consideration by all of us.

Paradoxically, the very next issue of *Science* [131, 1307 (1960)] contained a book review, by Harold L. Enarson, of *Science and State Government* by F. N. Cleaveland, which conforms to very few of Sarton's recommendations. Even more unfortunate, the review contains implied statements of fact that are undocumented, which are simply the opinions of the reviewer.

Particularly regrettable are the following passages in the review:

1) "The notion of shared responsibility between the federal government and the states in scientific activity is extravagant nonsense. The big money comes from Washington; the pattern and pace of government research effort

is determined in Washington, whether in research on agriculture or on mental illness."

2) "Scientific activity in the states reflects the traditional obsessions, notably the heavy emphasis on agricultural research and on applied research generally. Perhaps the states may be 'chasing the wrong rabbits'. . . . The talents of researchers at the state university are rarely mobilized to bear on the . . . problems of a state."

I hold no brief for Cleaveland's book. It undoubtedly has shortcomings that deserve critical comment. But the above quotations from the Enarson review are the kind of sweeping generalizations, highly charged with personal opinion unsupported by evidence, that one does not expect to find in a journal read by scientists. It is because the implications and conclusions of the reviewer are so patently contrary to fact that I feel impelled to call the matter to your attention.

On page 41 of the book, the federal contributions to state expenditures for scientific activities are listed. Among the six states surveyed, the federal support ranged from 10.3 to 33.6 percent. The average was 26.9 percent.

On pages 55-56, the text shows that federal contributions to agricultural research represented only from 7 to 22 percent of the total invested in five of the states. For one state (New Mexico) it was 31 percent. Thus, in fiscal 1954, the period covered by the survey reported in the book, the big money did not come from Washington in respect to total state expenditures for scientific activities, or in respect to state expenditures for agricultural research.

It is true the survey shows that 26 to 52 percent of the total state expenditures for scientific activities were in support of agricultural research. On the other hand, it is explained on pages 24-25, "the relative importance of research in agriculture is exaggerated by the limited amount the state expended on operating programs in agriculture—less than on the operations of the other three fields of governmental activity (that use research extensively)."

The operating programs in agriculture tend to be largely the responsibility of the federal government. The U.S. Department of Agriculture conducts research, but the funds available to the department for research in agriculture and forestry are a small fraction of the billions being used annually in the department's operating programs, such as crop acreage control and price supports.

Nor is this the only, or even the most important, factor explaining the apparently more generous support of research in agricultural experiment stations than in most of the other branches or col-

leges of the state institutions to which the experiment stations are attached. The difference is due in large part to the accounting procedures in most land-grant institutions. Except in agriculture, the practice is to assume that a professor uses 10 to 50 percent of his time in research as a necessary part of his responsibility as a teacher, particularly where graduate instruction is provided. A modest estimate is that at least a quarter of the expenditures charged to instruction in the nonagricultural segments of most land-grant institutions are essentially the same as those charged to research in the experiment station.

Those who have had experience on the senior staff of representative state agricultural experiment stations know that the administrators of these stations will not take dictation from officials of the U.S. Department of Agriculture. Neither will they permit such officials to impose their will on members of the station staff.

It is true that the Congress now provides grants to the states for support of agricultural research, about 29 million dollars annually. But every dollar of this money is spent on research selected and conducted by the experiment stations in essentially the same manner as research financed by state funds provided the stations. No federal official can choose the studies on which the federal grant funds are spent, or pressure the research workers in the procedures used in doing the research.

A very considerable portion of the research conducted by the U.S. Department of Agriculture with its own funds is carried out in cooperation with the state agricultural experiment stations. This voluntary cooperation specifically recognizes, in written memoranda covering each cooperative study, the rights and independence of the cooperating parties. The fruitfulness of these joint activities of federal and state agencies engaged in agricultural research are constantly admired by agricultural research workers from abroad, who often express the wish that they could find ways of accomplishing the same teamwork in their home countries.

I would not want to imply that there never is any controversy between state and federal administrators of research. Neither group is made up of yes men. But to make the bold statement, as does the reviewer of the Cleaveland book, that "the pattern and pace of government research . . . [in the states] is determined in Washington, whether in research on agriculture or on mental illness", is to make a statement that simply is not true.

Finally, the reviewer would have been well advised to have been more discriminating when he wrote "scientific

activity in the states reflects the traditional obsessions, notably the heavy emphasis on agricultural research and on applied research generally. Perhaps the states may be 'chasing the wrong rabbits.'"

I happen to be associated with the agricultural experiment station in one of the six states covered in the survey reported in the Cleaveland book. Our station has on its staff at the present time 11 members of the National Academy of Sciences. Two years ago the Nobel Prize for science was awarded to a member of our staff for work he did in this station. The professor who trained this Nobel laureate, and who was also awarded the Nobel Prize in science, was likewise trained in this station. The belittling references to research workers in agricultural experiment stations hardly deserve consideration by persons familiar with the contributions to basic science and technology which have come out of the state agricultural experiment stations. My hope is that those who do not have this information will not be misled by the Enarson review, which makes such sweeping derogatory statements.

NOBLE CLARK
*Agricultural Experiment Station,
University of Wisconsin, Madison*

I welcome the opportunity to respond to Noble Clark, who finds my review of *Science and State Government* inadequate and unfair—inadequate by the test of Sarton, unfair by the test of his one example, the agricultural experiment station.

I reread Sarton with trepidation. Had Sarton forbidden the expression of opinion, decreed that all general comments be elaborated, documented, footnoted? If so, I—and for that matter most other reviewers—am guilty as charged. But of course Sarton said no such thing; indeed he urges that reviewers not be fearful of expressing judgment, realizing always that a judgment is "at best, imperfect and precarious."

But, enough of Sarton. His excellent advice is not in issue. Let's move to the points of difference between Clark and myself. He quarrels with my convictions that (i) "shared responsibility" between the federal government and the states in scientific activity is more myth than fact; (ii) "The big money comes from Washington; the pattern and pace of government research effort is determined in Washington . . ."; and (iii) "Scientific activity in the states reflects the traditional obsessions, notably the heavy emphasis on agricultural research and on applied research generally"—with the result that "the talents of researchers at the state university are

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rarely mobilized to bear on the . . . problems of a state."

He is entitled to challenge these judgments. But his arguments should be addressed to these points, not to imaginary slights. There are no "belittling" references to research workers in agricultural experiment stations in my review. I did *not* say that the experiment station research workers might be "chasing the wrong rabbits," but rather that the *states* might be doing just that in the over-all pattern of their research effort. And I am at a loss to see the relevance of the prideful reference to Academy and Nobel Prize winners at Wisconsin. To dispose briefly of another straw man, I did not—as Clark implies—assert that federal officials "pressure the research workers," nor did I suggest that administrators of experiment stations "take dictation from officials of the U.S. Department of Agriculture." These are your own windmills, Don Quixote, not mine.

First, "shared responsibility" between the federal government and the states for research. Let's look at the facts. Does such a phrase really describe the various ways in which research programs are financed by the Department of Defense, the Atomic Energy Commission, the National Science Foundation, or even the Department of Agriculture? Is there sharing with the state when the Defense Department buys research from the Rand Corporation, or the University of Wisconsin? Is there "sharing" in the proposal that a \$100-million linear accelerator be financed at Stanford University, in the National Science Foundation grants for support of the National Radio Astronomy Laboratory, in the AEC grants to universities for building nuclear reactors? Is there "sharing" with the states in the medical research programs of the National Institutes of Health? In 1960, the state-government contribution to medical and health-related research is estimated at \$20 million; this is 3 percent of the total bill, of which the federal government pays over half. Moreover, the federal share is increasing steadily, with the latest estimates that by 1970 \$2 billion of the \$3 billion for medical research will in all likelihood be provided by the federal government (see the testimony of the Committee of Consultants on Medical Research; Labor-Health, Education, and Welfare Appropriations for 1961; Hearings before the Subcommittee of the Committee on Appropriations, U.S. Senate, 86th Congress, Second Session on H.R. 11390).

In none of these large grant programs, which constitute the bulk of federal research effort, are the grants shared—or even cleared, processed, or channeled through the states. Shared responsibility indeed!

As for agricultural research, is not the phrase *shared responsibility* more likely to obscure than to illuminate this complex relationship? See Charles Hardin's book *The Politics of Agriculture* for an analysis of some of the forces shaping the nation's agricultural research programs. Surely if we are to critically appraise the many complex and different ways that federal research grants are made, we cannot be content with rhetorical phrases such as *shared responsibility* and the conventional wisdom which indulges such cliché-thinking.

Second, the federal dominance in research. Who calls the piper, Washington or 50 state capitols? In fiscal 1959–60, the federal government will spend more than \$750 million to finance university research. Seventy percent of all research conducted by universities is federally financed.

The "pace and pattern" is set by Washington.

Example: The major research efforts in health have been launched because the Congress chooses to invest larger and larger sums in medical research: \$3 million in 1940, \$380 million (estimated) in 1960.

Example: The pattern in medicine has been that of individual project grants. The National Institutes of Health are now pressing for "institutional grants," to restore to the universities some freedom in determining which investigators and which research interests they wish to support.

Example: In physics, 90 percent of university research is supported by federal funds; the pattern is set in Washington, on the advice of scientists, not in the state capitols.

Example: Federal research is heavily concentrated. Five universities have over \$20 million of federal research funds, and one is reputed to have over \$90 million.

The issue is not whether federal officials lay hands on university researchers and control their individual research effort. Rather, the point is that the pattern of university research is profoundly shaped by the availability of federal funds. And these federal funds may encourage applied research to the detriment of basic research, may tempt universities to rely unduly on the interests of federal agencies in shaping their research programs. In many fields, as Charles Kidd points out [*American Universities and Federal Research* (Harvard Univ. Press, 1959)], "one of the most significant effects of federal research funds has been to remove from universities the authority to make some decisions they formerly made. Which faculty members are to receive aid for their research and what amounts are they to receive? Such questions are now decided generally by scientific

groups meeting in Washington, not by persons or groups within the institution."

We need not deplore this, for there may be no other way to mobilize the nation's research talent in pursuit of nation goals. But surely there is no sense in playing the ostrich and denying the powerful impact of federal funds on the life of our universities.

Third, that scientific activity in the states "reflects the traditional obsessions, notably the heavy emphasis on agricultural research and on applied research generally." Let's put this to a practical test. Who has the best chance of getting money from the state legislator, the experiment station director seeking research funds to study the diseases of cranberries, or the sociologist looking for the causes and cures of juvenile delinquency? Agricultural research will win out most of the time for the simple reason that rural groups exercise disproportionate power in the state legislatures. I do not think it "belittles" the fine efforts of the experiment station workers when I reiterate my point: that "research on urban development, housing, and smog may be more urgent than the search for new varieties of rust-resistant wheat."

If this be heresy, I suspect it's the sort of heresy George Sarton might have enjoyed.

HAROLD L. ENARSON
*Western Interstate Commission for Higher Education,
Boulder, Colorado*

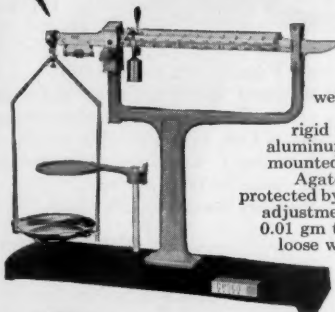
Information on Drugs

"Science in the News" in your 29 April issue [*Science* 131, 1299 (1960)], in commenting on the Kefauver drug hearings, reports the lack of a "convenient index of information" that would allow physicians "to sort out the misleading from the meaningful messages among the barrage of promotion to which they are subject. . . ."

A beginning in providing just such information has, in fact, been made in the form of a newsletter called "The Medical Letter on Drugs and Therapeutics." This fortnightly publication is issued by a nonprofit organization, it carries no advertising, and it is supported solely by the fees of its 14,000 subscribers, most of them physicians. With the aid of a distinguished advisory board of medical clinicians and investigators and a broad panel of special consultants, the editors of "The Medical Letter" provide subscribers with concise, authoritative, and unbiased appraisals of both new and old drugs.

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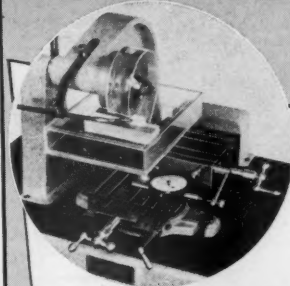


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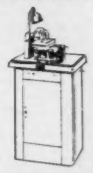
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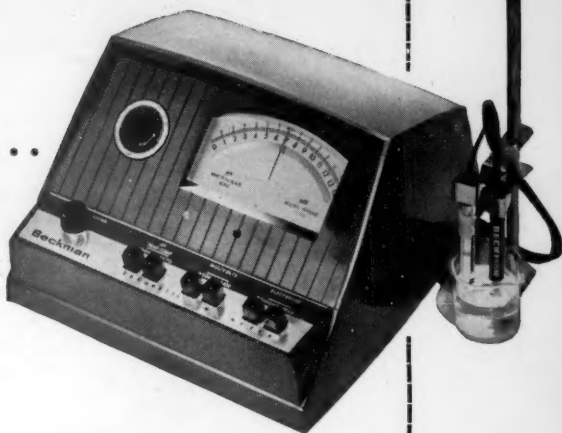
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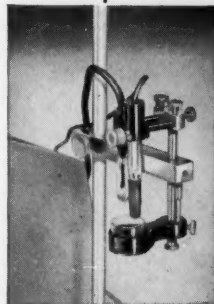
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